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PRODUCT ENGINEERING

GRAW-HILL WEEKLY FOR DESIGN ENGINEERS

MAY 15, 1961

DESIGN SHOW ISSUE

VQR

eliability...

uality...

ALUE...

the emerging emphasis in design

SEE PAGE 3

BEST BUY FOR AIR SUPPLY

UP TO 5hp... NEW WORTHINGTON MONOBLOC X-COMPRESSOR

Based on purchase price, on extremely long compressor life . . . and on safety, too . . . your best buy for a 1½- to 5-h.p. air supply is the new Worthington MONOBLOC X-Compressor.

First, the MONOBLOC saves you $30 or more for parts and labor because it comes completely wired. There's no starting switch to buy and install and wire in.

It's more economical, too, because all your money goes to buying a quality motor, compressor, controls and tank. You don't waste it on unnecessary belts, belt-guard, sheaves, long base and on the labor required for assembling them.

Is floor space important to you? The MONOBLOC vertical tanks save over 60% of space required by old-style horizontal units. A 10" radius circle for the 60-gal. tank; a 12" radius circle for the 80-gal. tank.

The MONOBLOC costs less to run. All power goes to the compressor—no power loss in belt friction. (No belt guards or belt replacements.)

Of course, you want long compressor life. The MONOBLOC is built with the new Worthington X-Compressor design that virtually eliminates harmful vibration. The wide-stance X-shape design reduces vibration to the point where a coin can be balanced on the unit during starting, running and stopping.

A silicon-treated filter element removes over 99% of the dirt from incoming air—the most dangerous source of compressor wear. Tapered roller bearings cut friction. The large lubricating oil sump permits better cooling, less danger from low oil supply. These and other design features assure extremely long compressor life.

We and our distributors are ready and happy to show you why there's no better way of buying cheap air today. Call the Worthington Distributor listed in your Yellow Pages. Worthington Corporation, Section 34-8, Holyoke, Massachusetts.

WORTHINGTON

PRODUCTS THAT WORK FOR YOUR PROFIT

PRODUCT ENGINEERING

McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS

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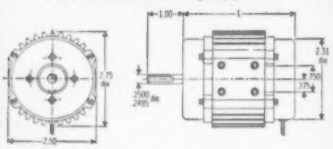
←CIRCLE 253 ON READER SERVICE CARD

AC

Thousands of these precision motors from Air Marine have been used both by the military and industry. The "E Frame" shown below is offered in either induction or hysteresis synchronous versions.

"E FRAME" (Finned)
3.68" Overall Length
For Continuous Duty Application



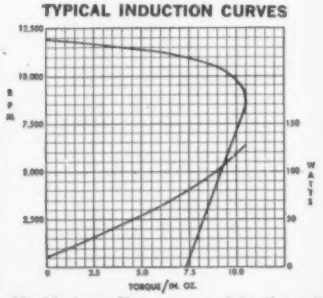
Induction

200 V., 3 phase 400 cycle
1/10 H. P. at 10,500 RPM
Torque, Starting 7.3" oz.
Torque, Running 9.0" oz.
Insulation to specs.

Hysteresis

115 V., 1 phase 400 cycle
Sync. Speed 8000 RPM
Starting Torque 3.0" oz.
Pull-in Torque 2.6" oz.
Pull-out Torque 2.7" oz.
Locked Rotor Current .92 amps

TYPICAL INDUCTION CURVES



Air Marine offers a complete line of fractional AC motors, blowers and fans. Motors range in size from 1/1000 to 1/2 H. P. 400 cycle units are designed for airborne application. Specify your needs and let Air Marine deliver.

air marine motors, inc.

369 BAYVIEW AVENUE
AMITYVILLE, L. I., N. Y.

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LOS ANGELES, CALIFORNIA

Top Two Together

Complete Line Now Available

Air Marine Motors of Amityville, New York and Motordyne of Los Angeles, California have combined to offer industry an extensive line of both AC and DC motors in the fractional horsepower range. Motors from these companies have for years fulfilled the requirements of both industry and military. The wide variety of types offered makes this source invaluable to the design engineer. Comprehensive literature on units to fulfill specific needs is available from either the east or west coast facilities.

Quality is a Statistic

Motors from Air Marine and Motordyne have gained a reputation of reliability based on the quality of performance. Numerous units designed for the military have continually met rigid environmental requirements. Hundreds of pages of statistics are available to establish beyond any doubt the ability of these motors to meet all types of specifications.

Research and Development

Laboratories are maintained on both the east and west coasts, under the direction of highly competent engineers who continually probe for more advance techniques in the manufacturing of rotating components. The AC and DC motors of these corporations are continually being studied to increase their life and efficiency. These laboratories also study specific problems of customers relative to motor performance.

Engineering Consultation

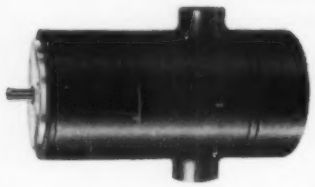
The field engineers of Air Marine and Motordyne are trained to assist the customer in the selection and installation of motors. These engineers are often called upon by the customer to assist in specifying the right motor for a specific job. A call to either the east or west coast facility will alert these engineers to your specific problems.

Additional Lines from Air Marine and Motordyne

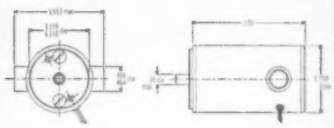
Now from these extensive facilities a complete line of blowers, fans, governors, breaks, gears, servo motors and thermal overload switches have become available: Complete information is available on request.

DC

Another precision motor from Motordyne capable of meeting the most stringent specifications. Hundreds of planetary gear speed reducers are offered as well as brakes, governors, clutches and thermal overload switches.



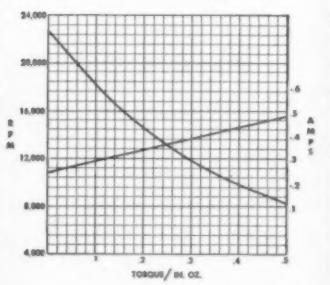
SERIES 1200, REVERSIBLE MOTOR



Power Supply	24-28 volts
Line Current	.5 Max. amps
Speed	10000 RPM
Output	.004 H. P.

Continuous Duty .5" oz.
Intermittent Duty 1.0" oz.

TYPICAL CURVE



If you face a DC motor application problem let a Motordyne field engineer assist in the solution. For prompt attention contact either the East or West Coast facilities.

MOTORDYNE INC.
a subsidiary of air marine motors, inc.

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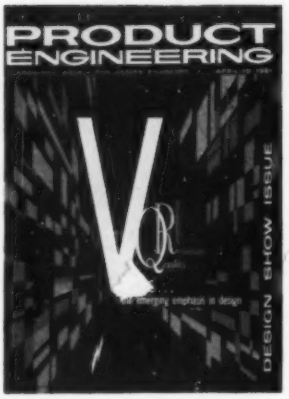
INTERESTING TO NOTE

What Price Bargain?



There's an old story about a man who, when offered an elephant at $500, thought the pitchman a little crazy—what in the world would anybody do with an elephant? But when the price came down to $50, he closed the deal. Who could refuse at such a price?

As long as there have been shoppers, there have been bargain hunters.

And bargain hunters often end up by being stung. But there have been successful traders—who learned to get what they wanted or needed at a favorable price.

In engineering, as in any profession, getting the most for your dollar is just common sense. But now we have a better name for it, "value analysis"; or, in the area of engineering, "value engineering." And it's not as simple as it sounds, the special report on page 79 points out.

Larry Miles (of General Electric, Schenectady) father of value analysis, suggests in his *Technique of Value Analysis and Engineering* (to be published this August by McGraw-Hill Book Co), "Value analysis is a philosophy implemented by the use of a specific set of techniques, a body of knowledge, and a group of learned skills." As an example, he tells of an appliance company that spent $20,000 annually for a million knobs—on each of which was mounted a strip of bright metal containing a red pointer. A value engineer analyzed the situation and found that the part was that expensive because its manufacturer considered it a "nameplate" which "imposed certain costs and restrictions on its manufacture." The value engineer next checked with an industrial stylist and found that the red arrow "caused the product to look more like a toy and less like the mature, reliable product that is was." So the knob was replaced with one of polished stainless steel . . . at a savings of $13,000.

Value analysis, of course, needn't be limited either to the man who bought the elephant, or to the engineer developing a manufactured product. Its basic philosophy can easily apply to the man buying a new house—or his wife shopping for the family groceries.

When Oil Beat Tallow

Towards the mid-1850s, America was rapidly emerging as a world industrial power. Her machine tools were on a par with their English rivals; her technology was growing faster than Britain's. There was one drawback: industrial machines needed better lubricants. Too often, machines designed for rapid operation had to run at

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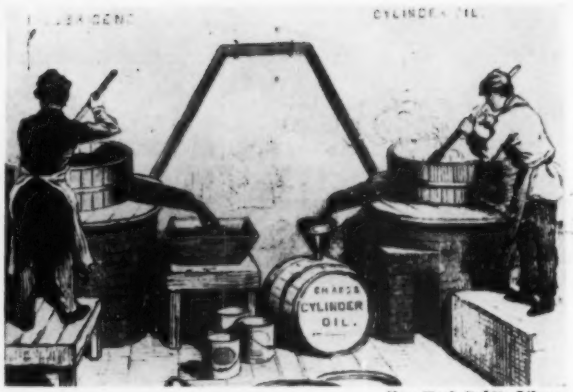
quarter-speed. Tallow and animal fats were about all that was available. Some machinists tried camphene, a mixture of turpentine and alcohol, but large-scale use was impossible—it produced a poisonous gas. Some saw possibilities in petroleum, but couldn't do much about it. The only way to collect oil was to find where it mixed with water and literally skim it off the top. A hard day's work produced only three to six gallons and the cost was prohibitive.

Then, in 1859, Col Edwin L. Drake drilled an oil well near Titusville, Penna. No one had ever looked beneath the earth's surface for oil. Drake's find started a revolution. Thousands of people rushed into the Pennsylvania oil region. Entire cities sprang up over night within a 50-mile radius. In five years, the petroleum industry was a major force in America's life. Apart from the needs it met in lighting and manufacturing, the industry itself created other new industries. Oil transportation, for example, started with crude barrels and storage "dug-outs," and progressed to tank cars, ships and pipelines.

But petroleum as a lubricant was still to be discovered. It took the back-room dabbling of a Rochester, NY grocer named Hiram B. Everest to find out how to obtain a good lubricant from crude oil. In 1866, he discovered that after kerosene had been removed by distillation the residue was unscorched. He decided to sell this residue as a lubricant in place of the animal and vegetable fats then used. Everest invested all his money in a shed-size oil plant, only to be met with scorn by investors and users of tallow. Nevertheless, he packaged his product in salvaged oyster cases and peddled it from shop to shop. One by one, machinists agreed to sample Everest's product and one by one they agreed that its properties far exceeded those of the older lubricants. Everest had found a new use for oil.



New York Public Library

Early refinery techniques required hand labor. Here, two men are processing cylinder oil, one batch at a time.

Oil as a lubricant (see page 98) was only a beginning of the booming new industry. The next major development occurred several years later. The demand for gasoline was growing at a tremendous rate and scientists quickly realized that its demand would soon surpass that for kerosene. In 1913, Dr William M. Burton built the first cracking-still, which replaced the more primitive straight-run distillation method and doubled the yield of gasoline from a barrel of crude oil. Burton's thermal-cracking process opened the way for modern techniques that enable refiners to obtain an average yield of about 45% gasoline from each barrel of crude. Thermal cracking is still used in the production of some motor fuels, although catalytic cracking is now more widely employed to obtain the higher octane gasoline.

—Benedict A Leerburger Jr

NEXT WEEK IN PRODUCT ENGINEERING

. . . Master-Design Award Winners

Description of the winning entries in this year's contest.

. . . Temperature-measuring Transducers

Unusual transducers, previously considered experimental, are now helping solve practical engineering problems. Here's a special report on the state of the art.

. . . Preshaped Epoxy Adhesives

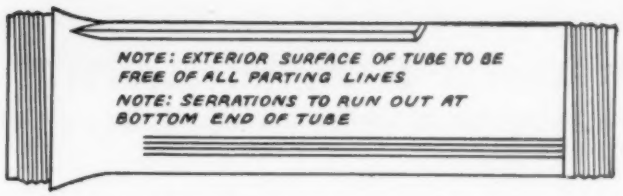
Like preforms for soldering and brazing, these adhesive pellets contain just the right amount of joining agent—shaped to fit the joint.

. . . How to Select Threaded Inserts

Will a particular insert meet the given strength requirements; and which insert is more economical?

. . . Designing Shells for External Pressure

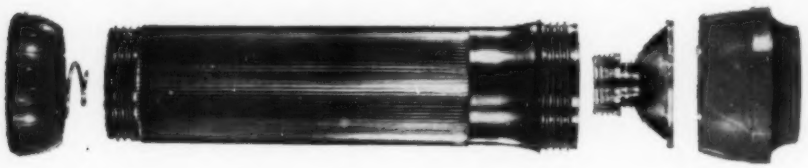
Two nomographs find wall thickness needed to prevent splitting of thick-wall cylinders or buckling of thin ones.



All-plastic case shows finely drawn functional detail—Tube, lens ring, and cap are all molded of BAKELITE Brand high-density polyethylene. The designer made good use of this material's functional properties. Fine details are reproduced with fidelity—serrations on the tube are precisely formed and provide a firm grip. Minimum finishing after molding helps keep mass production costs low. Tough and rigid with excellent chemical resistance, the flashlight will take hard usage. Its gloss adds sales appeal. On top of all these design advantages, the low price of this material makes it an even stronger value.

Molded-in threads, hidden parting line make this design unusual—Because of the high temperature resistance of BAKELITE Brand high-density polyethylene, these flashlight components always hold their shape. The molded ten-pitch threads don't soften, keeping the lens ring and cap firmly in place.

While the threaded sections at the bottom and top of the tube required a parting line, the designer specified that the main body of the tube have no parting line. The one-piece mold used for this feature costs more, but the appearance of the finished product makes it worthwhile. A slight taper in the tube permits easy removal from the mold. Since holes for the switch plate are molded in, there's no need for drilling or piercing.



HIGH-DENSITY POLYETHYLENE

...Idea-material for new designs

The Eveready "Shop Lite" gained several advantages when the designer chose this new polyethylene. Check the high points on this page . . .

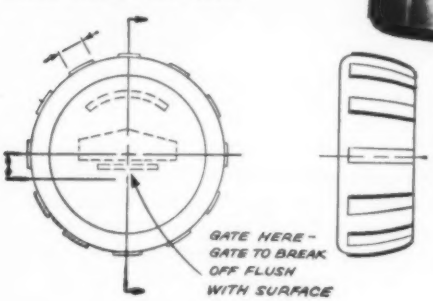
A new material often expands the designer's opportunities to try new ideas. This is especially true of high-density polyethylene, which offers properties that can reduce costs, extend performance, and improve appearance. Polyethylenes are only one group of BAKELITE Brand Plastics—the others are epoxies, phenolics, styrenes, and vinyls—that you can draw on. Molded, laminated, extruded, and in coatings, BAKELITE Brand plastics can be a source of genuine product improvement.

Check their properties in Sweet's Product Design File, Section 2a/ui.

This was an informal test—but it demonstrated the toughness and impact resistance of the BAKELITE Brand high-density polyethylene used in the EVEREADY "Shop Lite." It came through the bump, bounce, and batter undamaged.

Clean mold gating, color, feature high-density polyethylene – The designer called for a conventional gate on the flashlight cap mold; the tube and lens ring molds have a "diaphragm" gate used in fabricating tubular plastic designs. See how the finished part compares with his design. The cap and lens ring come in three glossy colors – red, yellow, and green—an attractive combination with the black tube.

Visit our booth at the Design Engineering Show, Cobo Hall, Detroit May 22-25.



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Please send me information on the use of BAKELITE Brand plastics in design with particular emphasis on these properties _____.
The type of application being considered is_____
_____

NAME _____

FIRM NAME _____

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CITY_____ ZONE_____ STATE_____

WHAT'S HAPPENING IN RESEARCH . . .

Zinc-columbium coatings doing well at 1200 to 1800 F

Since their first report, about a year ago, Naval Research Lab scientists have found zinc-columbium cover coats more than live up to expectations as protection for columbium metal at temperatures at least to 1800 F. The coatings are not entirely stable to that point. At 1200 F, they begin to release zinc vapor. But this is an advantage. The vapor is converted to zinc oxide, deposits itself on top of the coating, and prevents oxygen penetration. However, above 1800 F, rate of vaporization is so rapid that it ruptures the oxide barrier.

In an attempt to solve this problem, NRL's Metallurgy Div has been trying a number of approaches: among them, alloying the zinc-columbium coating with other metals. Addition of nickel and aluminum to the zinc melt is helpful in the 1800-F to 1900-F range. Above 1900 F, though, alloyed coatings show little improvement over the unalloyed.

Ternary alloys, formed by adding large amounts of titanium to the columbium-zinc combination, may do the trick. Preliminary tests indicate that rate of oxidation at 2000 F decreases with increasing titanium content, at least until 90% (by weight) is reached.

Work is continuing, both on methods of producing the coatings (hot-dip, vaporization) and on the mechanism of protection.

Dry-lube bearings fail wet-lube tests

Working-surface combinations that run well at high temperatures under dry lubrication or no lubrication at all may not prove serviceable when lube oil is used, say G. F. Hyde and J. H. Fuchsluger of Koppers Metal Products.

They've been making screening tests on contact-surface materials, coatings, and lubricants for service to 1000 F, and have a number of interesting findings to report. In regard to dry vs wet lubrication, they say:

Flame-plated tungsten carbide vs titanium carbide, a good performer in dry brake-shoe wear tests at room and elevated temperatures, was badly scuffed in a rod-and-seal bearing application even at 400 F when a synthetic oil was used.

Tungsten carbide against tungsten carbide, a star performer in the dry tests, showed even more severe scuffing when run wet. Results were basically the same regardless of type of lubricant.

Possible explanation: As parts run dry in air, they create their own dry-film lubricant as a wear byproduct. When the air atmosphere is excluded, as it is when lubricants are used, the dry film cannot form.

briefs . . .

Melting points well above 6000 F are calculated for tantalum carbide and low-carbon tungsten alloys by C. F. Zalabak of Lewis Research Center. A new series of tests show tantalum carbide (4¼ to 5½% C) can resist melting at least to 6360 F, may range as high as 6790 F. For tungsten, with carbon content held in the range of 15 parts per million, the melting point is now set at 6165 F. Values below 6000 F reported by other researchers seem to have been obtained with samples in the 70-ppm range, and there is evidence that melting point decreases with increasing carbon content.

Sounder aluminum castings can be produced by injecting red phosphorus into the melt and following up with a sodium treatment, the Italian Institute for Light Metals Testing (Instituto Sperimentale Metalli Leggeri, Via del Lavoro 2, Novara, Italy), reports. The phosphorus lowers the calcium content (a prime offender in causing casting defects), and the sodium takes out any excess phosphorus.

Electrical resistance of thin films varies with the environment in which they are placed, Helmut Schwartz of United Aircraft Corp reports to the American Physical Society. Nickel-chromium films on ceramic substrates showed a temperature coefficient of resistance significantly lower in vacuum than in argon, in air, or silicone oil; and results were substantially the same whether the samples were uncoated or protected by a thin silicon monoxide film. Of the latter 3, the argon-bathed samples showed the lowest coefficient. Measurements were made over a temperature range from −65 to 300 F, and temperature coefficients were on the order of 5 to 50 ppm per deg C. **–ARG**

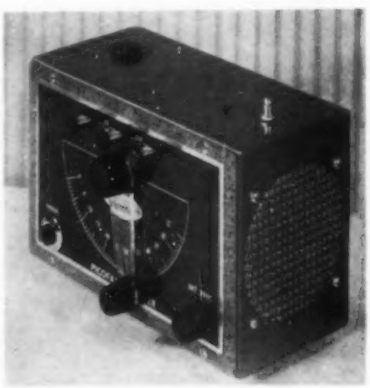
Low-cost meter for low-range capacitance

An instrument that measures capacitances in the 0 to 550-picofarad range is being introduced by F C Robinson & Partners, Ltd of Cheadle, Cheshire, England for laboratory use.

The meter is simply a loudspeaker fed by 2 oscillators. One oscillator has a fixed frequency of 1.5 mc; the other is variable. Its output is a combination of the main tuning capacity, a "set zero" control, and any "unknown" capacitance placed across the test terminals.

The meter is adjusted to zero beat, the capacitor to be tested is placed in position, and the unit is again adjusted to zero. Difference between the two readings gives the "unknown" capacitance.

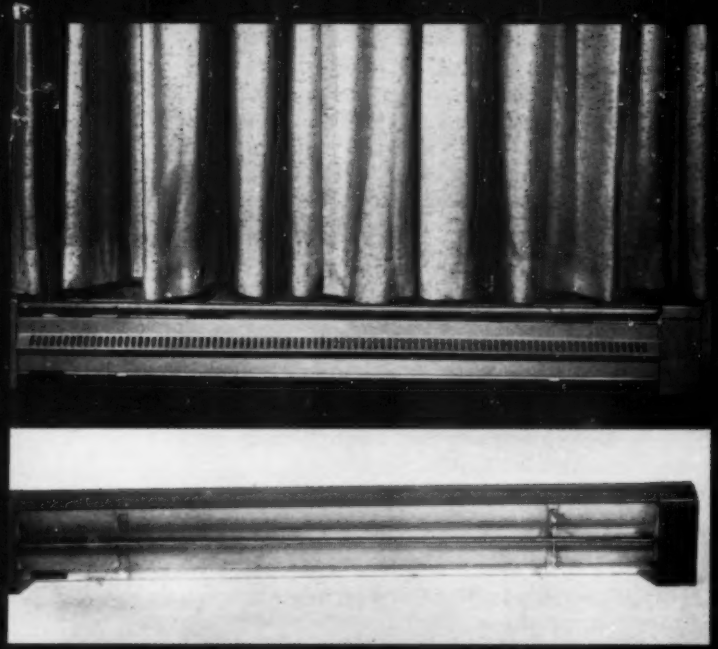
The meter has two ranges, 0 to 55 pF (with scale markings representing 1 pF) and 0 to 550 pF (with calibrations of 10 pF). It is fully transistorized, and only one 4½-volt battery is needed. Weight is 6 lb. Price: about $48 (US equivalent).



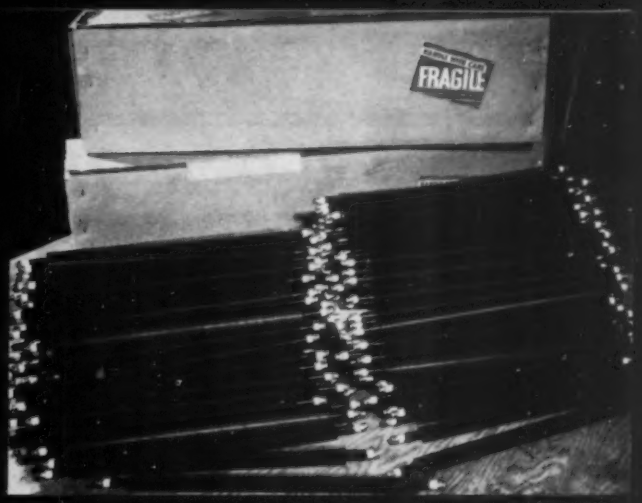
PICOFARAD METER is battery-operated, measures 8 by 5 by 4½ in.

CIRCLE 7 ON READER SERVICE CARD→

"Maximum Efficiency —Minimum Space"



Wolverine Trufin Type H/A in TruHeat baseboard heating.



Anodized Trufin meets MIL specs for aircraft use.

Trufin used in Truheat's defrost heater.

Wolverine Trufin® Type H/A in The TruHeat Line

Yes, you get the maximum efficiency possible in a minimum space when you use Wolverine Trufin in your products. That's the experience of TruHeat Corporation engineers in Allegan, Michigan. Manufacturers of electrical heating equipment, TruHeat uses Trufin Type H/A (in aluminum) for baseboard heating, in defrost heaters for refrigeration units, and in aircraft heating units made to military specifications.

TruHeat engineers also point out that because Trufin is all one piece, there is no bond to loosen up in the expansion and contraction resulting from the continuous heating and cooling cycle changes. Trufin is unaffected by vibration or by sudden thermal shock, too. It is consistent in dimensions, thus eliminating rejects for under or over tolerance.

Finally, in TruHeat applications, Trufin meets MIL specifications for vibration tests, corrosive atmosphere tests and shock tests.

Type H/A is only one of the many types of Trufin made by Wolverine Tube, Division of Calumet & Hecla, Inc. There are successful applications for Trufin in many, many industries. Why not write for complete information today?

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. M, 17278 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

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DEVELOPMENTS TO WATCH...

More high-temperature magnet wire coming

For service at ambient temperatures from 500 to 1100 F, Inca Manufacturing Div of Phelps Dodge Copper Products Corp, Fort Wayne, Ind, is developing new types of ceramic-coated high-temperature magnet wires capable of long life in their specified temperature ranges. Among them: a 10% nickel-plated copper, a 28% stainless steel-clad copper, a 28% nickel-clad copper, and a 20% nickel-clad silver.

Some of these are for the lower range (to perhaps 650 F or 800 F); others show promise for use even above 1100 F.

The ceramic coating is itself a new Phelps Dodge development, described only as "a flexible, fully cured ceramic composition fused to the wire." Not yet commercial, these coated wires are currently undergoing an extended evaluation program.

New nylon-type polymer shows high strength and stability

A new nylon-type polymer for moldings, films, and fibers is in the development stage at California Chemical Co.

It's a polyamide of somewhat different composition than the standard types; and, California says, it shows good dimensional stability even under conditions of high humidity. Oriented film has "superior tensile strength and very low oxygen permeability; and the fibers are also said to show high strength and a high modulus."

The material (MXD-6) is not yet in commercial production, but has reached the market evaluation stage.

Iron Curtain countries test new electronic systems

Steam-cooled power tubes and dumbbell-shape waveguides are among the new electronic developments reported from Moscow.

The power tubes, and also a closed-system "antenna" in which hf energy is dissipated by heating of water, were exhibited by Hungarian firms at a Moscow industrial show late last year. The waveguides are so designed as to overcome the limitations of H-shape and rectangular units, and to show characteristics intermediate between the two.

According to the USSR *Technical Physical Journal* (v. 30, #9, p 1074) the cutoff wavelength for the fundamental mode of the dumbbell units is 5 cm, as compared to 4.6 cm for the rectangular and 6:05 cm for the H-type.

Brief description of these electronic developments and several other new ones from both countries are contained in the *Current Review of the Soviet Technical Press* (60-21441-33), published by OTS, Dept of Commerce, Washington 25, DC.

Miniature "true" ac coil relay under test

A new 400-cycle ac switching device that uses no rectifiers or auxiliary components is in the prototype stage at North American Aviation. It's a small unit—less than one cu in. in volume (NAA believes it can be made even smaller) and it seems adaptable for 27½-v dc applications as well as for 115/120 v ac.

The relay has 4 sets of Form C (four pole double throw) bifurcated contacts rated at 1.0 amp inductive (0.3 power factor) at 115/200 v ac, and a magnetic circuit that incorporates a bipolar shaded-pole magnet with a laminated rotary armature. Location of the shading coils on the relay coil cores is such that the relay armature seats against the relay-coil core pole faces; and armature and contact reciprocation are virtually eliminated.

Maximum relay-operating voltage is applied at the knee of the relay-coil core's magnetization curve, so heating effects are minimized. In addition, molybdenum and palladium contact materials and a molybdenum-and-ceramic header assembly are used to permit operation at elevated temperatures. The present model is designed for 250 F; and it is believed that this can be extended at least to 350 F.

A report on the prototype was presented by G. A. Marshall of NAA at the Electromagnetic Relay Conference, and work is now in progress on further improvements.

More semiconductor devices to measure stress and strain

An entire family of piezoresistive devices for measuring stress and strain is being developed at Bell Labs. All take advantage of the transverse or shear piezoresistive effect, but they differ in form and application.

One group consists of gages in the form of a thin rectangular sheet bonded to the test piece, and whose resistance change can be expressed as a simple function of the principal stresses in the test piece. This group includes a device in which the resistance change is proportional to the sum of the principal biaxial stresses for any orientation of the gage on the test piece; and one in which the resistance change is proportional only to longitudinal stress components, being independent of transverse stress.

Other piezoresistive devices under development at BTL, as reported by W. G. Pfann and R. N. Thurston, include a 4-terminal gage for biaxial stresses, full-bridge gages made from a single crystal, and load cells and new torque transducers.

Experimental models all use germanium and silicon; but, Pfann and Thurston say, other semiconductors can be used and may even prove superior in some devices.

These cements show promise for threaded joints

In a British attempt to find compounds that will provide a permanent seal over a wide range of testing, the UK Ministry of Aviation has been testing a number of new room-temperature-setting materials. Among the most promising:

- liquid phenolics based on cashew nut-shell resins.
- oleoresinous varnishes.
- chemical-set compositions that utilize the reaction between magnesia and oleic acid.

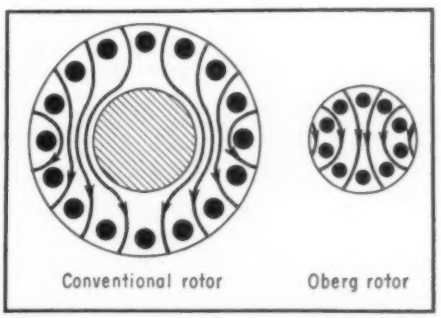
Best results so far have been with the liquid phenolic. This solvent-free cement is made by adding paraformaldehyde to the cashew resin. It gels to a soft rubber, then slowly sets to a leathery consistency. Runner-up was the oleoresinous paint, with the chemically setting magnesia-oleic acid composition coming in a relatively poor third. Other solvent-containing compositions tested (a natural rubber/resin cement, bituminous paint, and shellac) did less than half as well. The first 3 created successful joints in 80 to 105 of 105 samples; the others in only 19 to 57.

The fact that two of the three winners were solvent-free types, and the third (the oleoresinous varnish) dries by oxidation as well as solvent evaporation led to the general conclusion that "cements containing solvent are greatly inferior to solvent-free cements. No cement drying merely by evaporation of solvent satisfactorily seals threaded metal joints."

A report, giving design pointers as well as test results, has been prepared by R. W. Bryant and W. A. Dukes and is to be included in the proceedings of the British Hydromechanical Research Assn's International Conference on Fluid Sealing.

New small motors feature hole-free rotor

High-frequency motors of unusually compact design are being introduced by Oberg Machine Co AB of Eskilstuna, Sweden for use in hand tools, machine tools and the like. The motors are cylindrical in shape; one is 1.3 in. and the other 1.8 in. dia. One model that weighs only 12 oz will operate at speeds to 70,000 rpm at an input frequency of 1200 cps, with an output of 150 watts; another, weighing in at 32 oz, has an output power of 600 watts and maximum speed of 60,000 rpm.



ROTOR SIZE is reduced by elimination of center hole in new Oberg design, which also smooths magnetic field.

The small size is attributed to the rotor design (see diagram). It has no hole. Instead, the laminations are held together by rotor bars, forming a solid unit. This. says Oberg, not only reduces motor diameter, but also permits operation at high speeds and promotes efficiency because there is no disturbance in the magnetic field.

There is no US distributor, but H Williams & Son Ltd of St Albans, Herts, is Oberg's British representative, and displayed prototypes of the motors, along with converters designed to go with them, at Britain's Engineering, Marine, Welding and Nuclear Energy exhibition. —ARG

Gasket engineering

GASKET SEALS VS. FLANGE FINISH

Smooth flanges usually help simplify gasket problems . . . but they raise machining costs. Can a gasket material compensate so well for flange roughness that machining costs can be reduced?

E. M. SMOLEY
Research Physicist
Armstrong Research and Development Center

How smooth do flange surfaces in gasketed assemblies have to be? Is there a gasket that will seal so efficiently that less machining of flange surfaces might be practical?

To answer these questions, extensive tests were conducted at the Armstrong Research and Development Center, using rough (3000 micro-inch) and smooth (5 micro-inch) flange finishes.

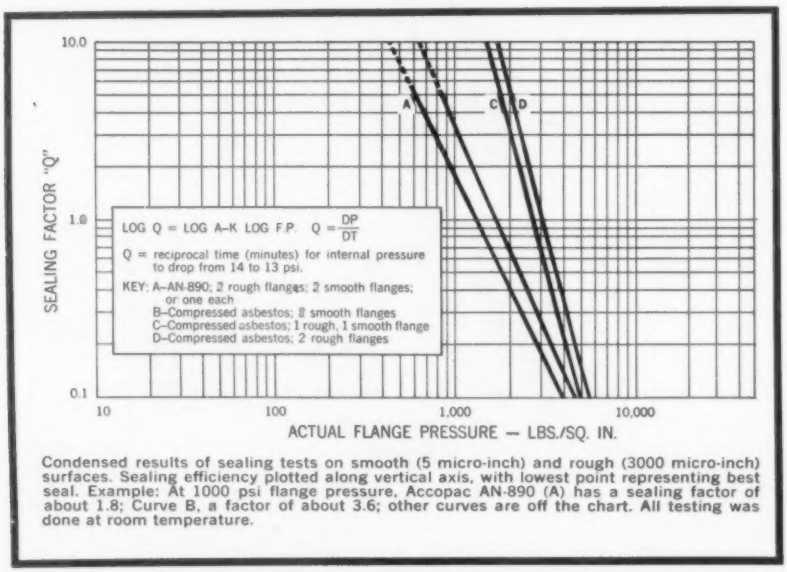
Two different gasket materials were compared: one, a standard grade of compressed asbestos; the other, Armstrong Accopac AN-890, a beater-saturated rubber-asbestos material. Both were 1/32″ gauge.

In each test, air was locked in gasketed flange assemblies at an internal pressure of 14 psi. Then pressure loss was measured and recorded as a function of time by the electro-mechanical air leakage tester developed by Armstrong engineers.

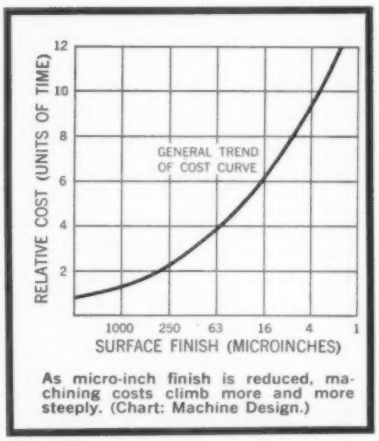
Many individual tests were run, using two smooth flanges, two rough flanges, or one of each. The results are condensed on the chart below.

The curves show that AN-890 Accopac has far better sealability with either rough or smooth flanges—or one of each—than the compressed asbestos material. Even at the relatively low flange pressure of 1000 psi, the unusual sealing ability of AN-890 is evident.

The superior performance of AN-890 is a result of the way it's made. The patented beater-saturation process gives a more uniform dispersion of rubber on fiber—hence, AN-890 is a more compressible material. As a result, it has unusual conformability to flange irregularities.


10.0
1.0
0.1
SEALING FACTOR "Q"
A
C
D
LOG Q = LOG A–K LOG F.P. Q = DP/DT
Q = reciprocal time (minutes) for internal pressure to drop from 14 to 13 psi.
KEY: A–AN-890; 2 rough flanges; 2 smooth flanges; or one each
B–Compressed asbestos; 2 smooth flanges
C–Compressed asbestos; 1 rough, 1 smooth flange
D–Compressed asbestos; 2 rough flanges
10
100
1,000
10,000
ACTUAL FLANGE PRESSURE — LBS./SQ. IN.

Condensed results of sealing tests on smooth (5 micro-inch) and rough (3000 micro-inch) surfaces. Sealing efficiency plotted along vertical axis, with lowest point representing best seal. Example: At 1000 psi flange pressure, Accopac AN-890 (A) has a sealing factor of about 1.8; Curve B, a factor of about 3.6; other curves are off the chart. All testing was done at room temperature.



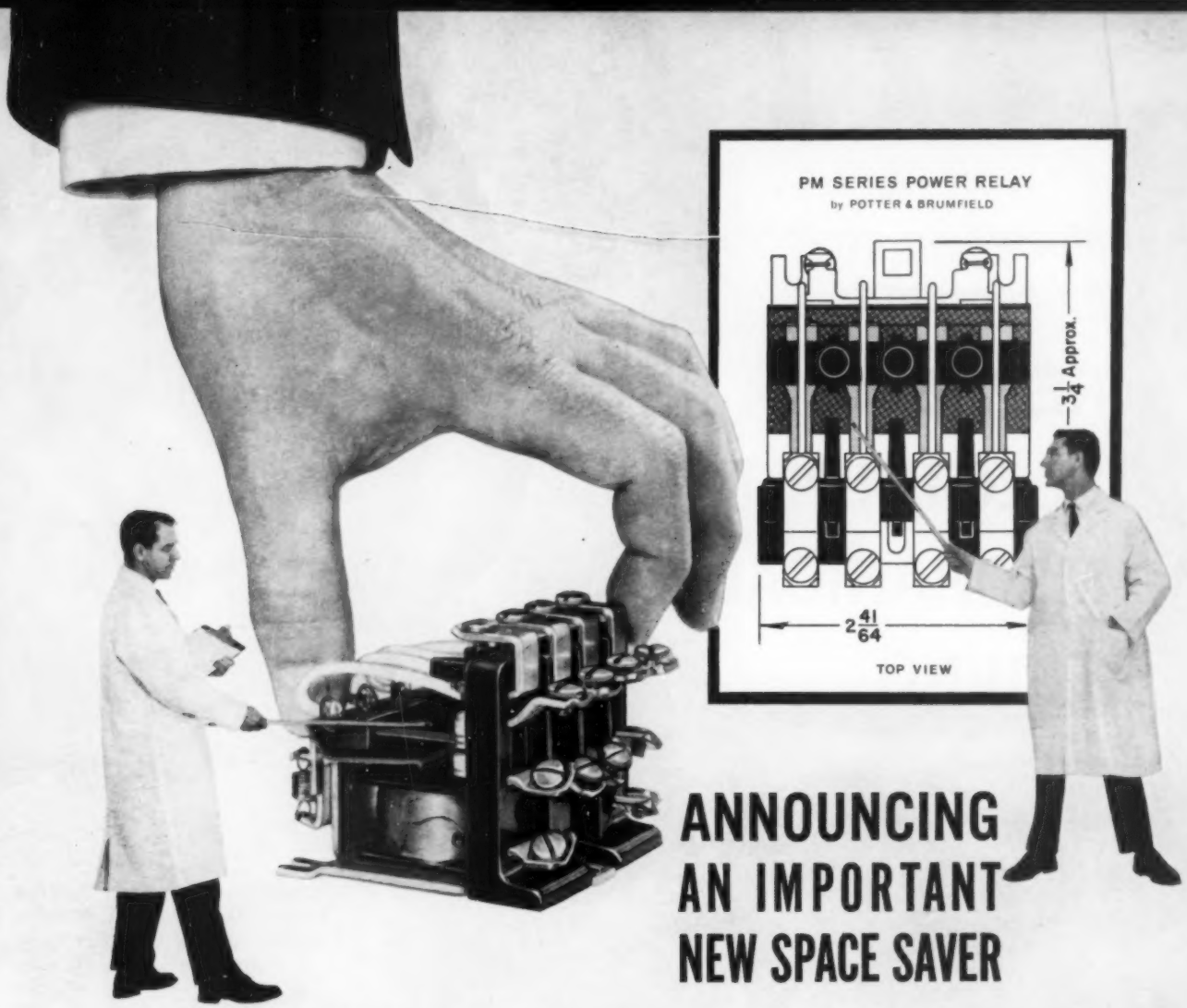
As micro-inch finish is reduced, machining costs climb more and more steeply. (Chart: Machine Design.)

These tests indicate that Accopac AN-890 offers definite promise of efficient seals at higher micro-inch flange finishes. Its use can make possible savings in machining costs that are well worth considering.

Research on gasket performance is a continuing project at the Armstrong Research and Development Center. Our large library of data may already contain the answers to your specific sealing problems. We will be glad to make suggestions if you will send details to us. Address Armstrong Cork Company, 7105 Irvin Street, Lancaster, Pennsylvania.

Armstrong GASKET MATERIALS

CIRCLE 11 ON READER SERVICE CARD→



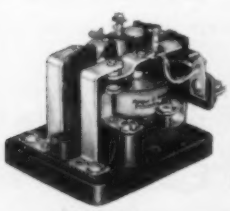
ANNOUNCING AN IMPORTANT NEW SPACE SAVER

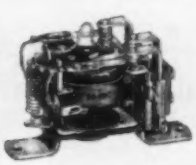
P&B compact 4PDT power relay switches one H.P. per moveable arm

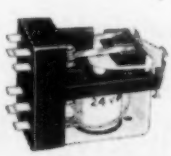
Save panel space! This new 4-pole relay is only 1/16" wider than our PR Series, America's most popular 2-pole power relay! Yet, it is engineered for reliable heavy-duty switching . . . and you can confidently expect 10 million mechanical operations.

PM Series relays are rated at 16 amperes (or 1 H.P.) at 115 volts, 50/60 cycles resistive . . . and special relays can be supplied for loads up to 25 amperes, at 220 volts, 50/60 cycles resistive. Heavy screw terminals are arranged for fast, easy hook up. An adapter plate is available for mounting PM relays in the same location used for 2-pole relays.

For full information, write today or call your nearest P&B representative.


PR Series


MR Series


AB Series

A whole family of power relays for a wide range of applications carry the P&B symbol of quality. Call P&B first for all your power relay requirements.

PM ENGINEERING DATA

GENERAL:

Description: Heavy-duty AC power relay.
Insulating Material: Molded phenolic.
Insulation Resistance: 100 megohms minimum.
Mechanical Life: 10 million operations minimum.
Contact Life: 100,000 operations minimum at rated load.
Breakdown Voltage: 2,000 volts rms minimum between all elements and ground.
Ambient Temperature: −55°C to +55°C.
Weight: Approximately 14 ozs.
Pull-In: 78% of nominal voltage.
Terminals: Heavy-duty screw type with No. 8-32 BH screw.

CONTACTS:

Arrangements: 4PDT or 4PST—normally open.
Material: ¼" dia. silver-cadmium-oxide.
Rating: 16 amps @ 115 volts, 50/60 cps resistive.
8 amps @ 220 volts, 50/60 cps resistive.
1 H.P. per moveable, 115 or 220 volts AC single phase.
25 amps @ 220 volts, 50/60 cps resistive available on special order.

COILS:

Voltage: 6 to 230 volts AC 50/60 cycles.
Power: 14 volt-amps average at nominal voltage.
Duty: Continuous.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONICS PARTS DISTRIBUTORS

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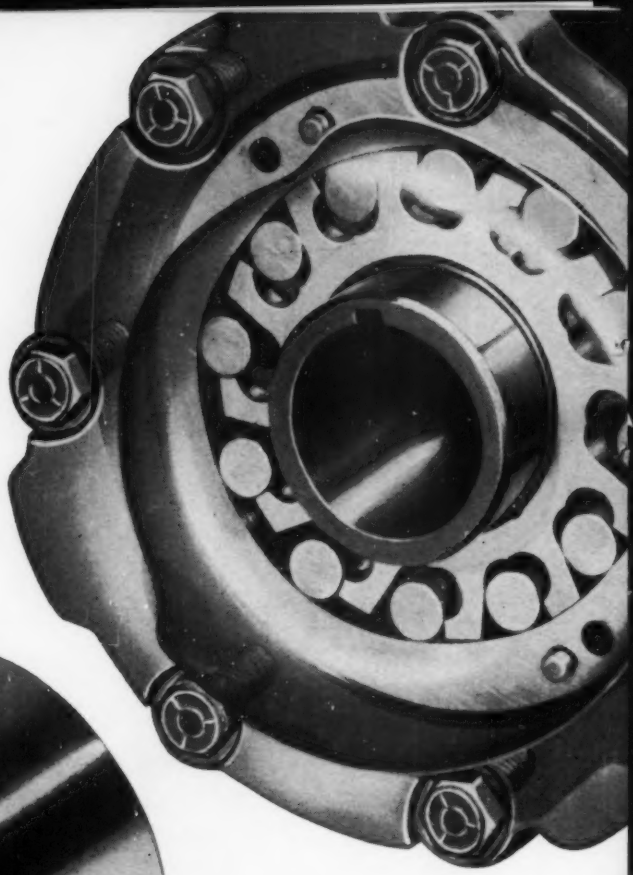
DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

Machining greatly reduced by concentricity of

REPUBLIC ELECTRUNITE MECHANICAL TUBING



CRITICAL PART IN POWER STEERING PUMP made with Republic ELECTRUNITE Mechanical Tubing. Keyed bushing fits over engine crankshaft, provides pump drive for power assist. Close tolerance machining is essential for dual mechanical-hydraulic function.

Precise concentricity of ELECTRUNITE Mechanical Tubing solved a machining problem and cut costs for Eaton Manufacturing Company, manufacturers of power steering pumps.

At the heart of the power steering pump is a bushing made from heavy wall ELECTRUNITE which serves as the internal shaft of the unit. It fits on the crankshaft of the car and drives the power steering pump.

The tubing is ground on both the ID and OD. A keyway is broached on the ID the entire length of the part, approximately 2⅝ inches. Another keyway is then milled on the OD.

Since Eaton must work to very close tolerances on the part, concentricity of the OD and ID of the tubing are most important to minimize machining.

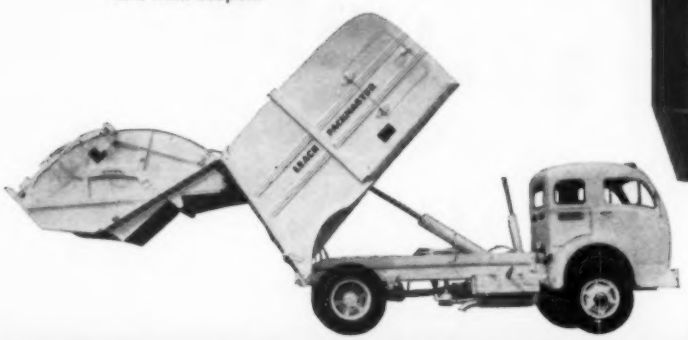
In addition, as it is part of a hydraulic system, the steel must be structurally sound without flaws of any sort.

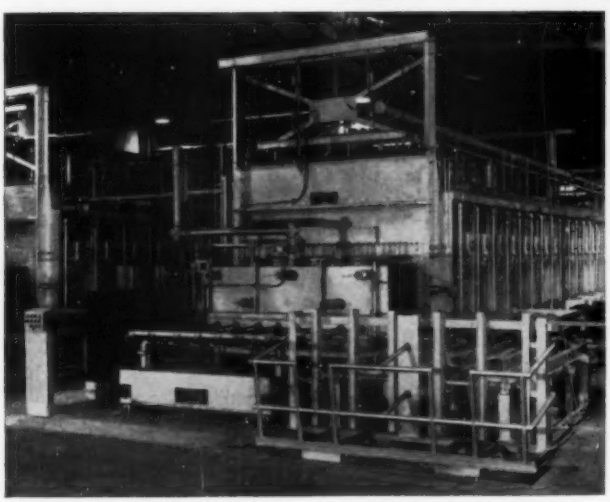
This is another example of how precision fabricated Republic ELECTRUNITE provides high quality and cost savings for critical applications.

ELECTRUNITE is available in a wide range of sizes, gages, and wall thicknesses in both carbon and stainless steels to meet your needs. For full information call your Republic representative or send coupon below.

CIRCLE 12 ON READER SERVICE CARD

COLD FINISHED ALLOY BARS form high strength pins to carry the full weight (up to 5 tons) of this Packmaster body and its refuse load when unit is hoisted to unload. Republic Cold Finished Alloy Bars, cut off, drilled, and chamfered by Leach Company, Oshkosh, Wisconsin, manufacturers of the Packmaster, offer the toughness and abrasion resistance necessary in this application. Investigate the advantages of using Republic Cold Finished Alloy Bars for your component parts production. Mail coupon.





NEW ANNEALING FURNACES provide maximum heat treating capacity for cold extrusion steel. Quality of steel produced at the Chicago Bar Mill attains a high level of uniformity through heat treatment in two new atmosphere-controlled annealing furnaces. These new furnaces provide the capacity to assure prompt delivery of orders for heat treated steels.

BENDING, FLANGING, SEAMING—ductile zinc coating on Republic Galvannealed Sheets stays tight, resists flaking, peeling, or spalling. Hot dip galvanizing plus special heat treatment give Galvannealed a graduated coating of iron—zinc alloys between the pure zinc outer surface and the base metal. The tough, uniform protective finish that is spangle-free provides a good paint base, withstands temperatures to 750°.

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REPUBLIC HAS THE FEEL FOR MODERN STEEL

Strong, Modern, Dependable

REPUBLIC STEEL CORPORATION
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1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

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- ☐ Republic ELECTRUNITE® Mechanical Tubing
- ☐ Republic Steel for Cold Extrusions
- ☐ Republic Cold Alloy Bars
- ☐ Republic Galvannealed Sheets

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Company_____

Address_____

City_____ Zone____ State_____

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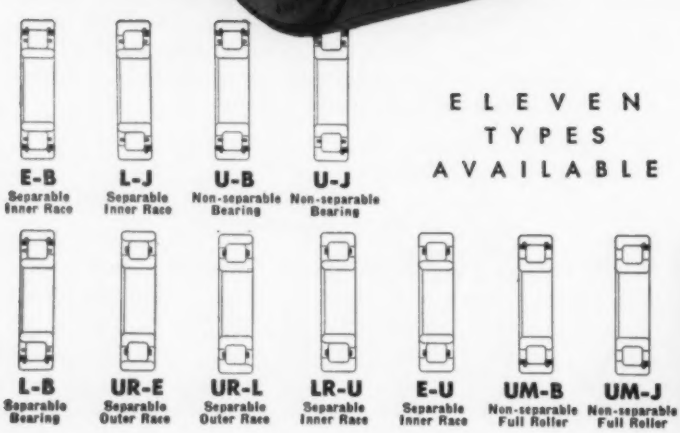
between maximum performance and moderate cost . . .

ROLLWAY Tru-Rol® BEARINGS

Give you more for your bearing dollar

For those hundreds of in-between applications where performance requirements are more exacting than those provided by the ordinary commercial bearing, but where maximum precision would be unneeded precision – specify Tru-Rol for the job.

Tru-Rol Bearings provide above-commercial-grade efficiency . . . at worthwhile savings in cost. Internal clearances are closely controlled. Rollers are equally spaced to eliminate out-of-balance vibration. Each roller is crowned to distribute the load evenly along the full length of the roller. Eleven types available in single and double width bearings, in stamped steel retainer, segmented retainer or full roller construction.



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Ask your nearby Rollway Service Engineer to detail the quality you *should be getting* in your "commercial grade" bearings. Or write for the Rollway Tru-Rol catalog showing the full line, and capacity and size ranges. ROLLWAY BEARING COMPANY, INC., Syracuse, N. Y.

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COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

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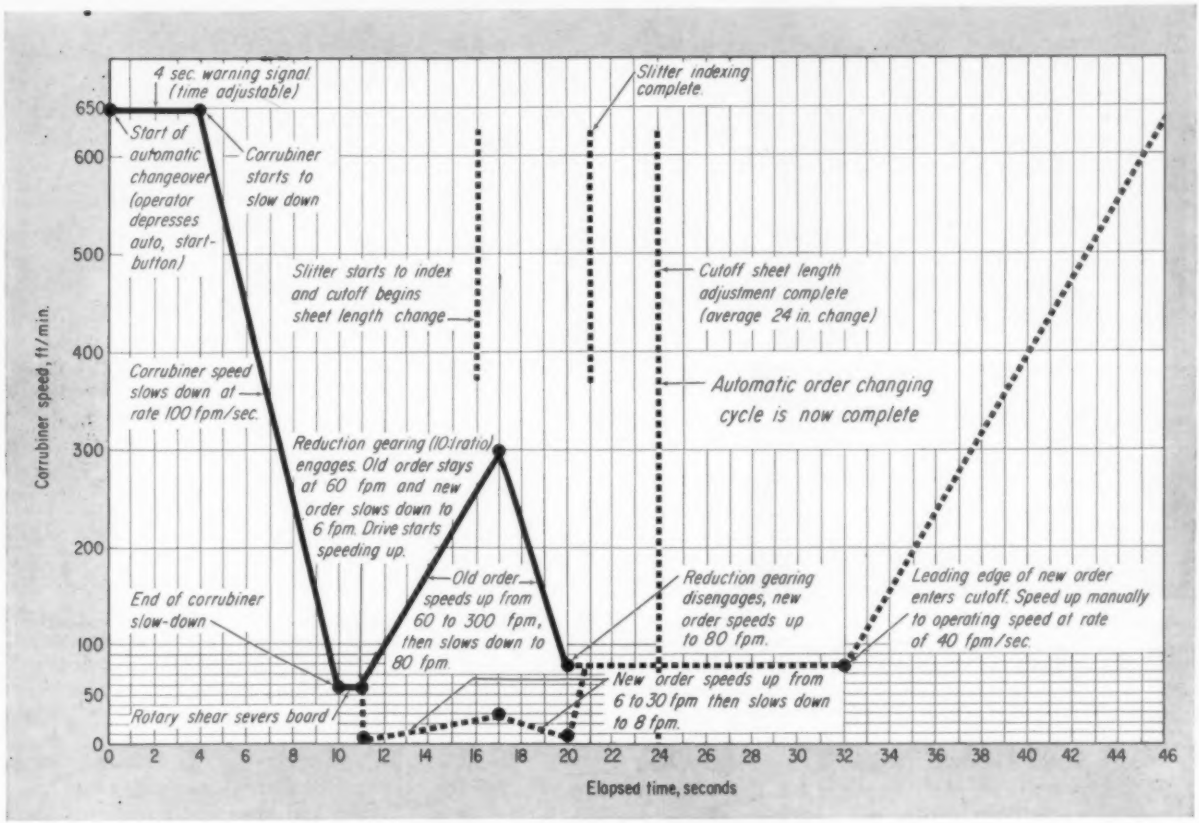
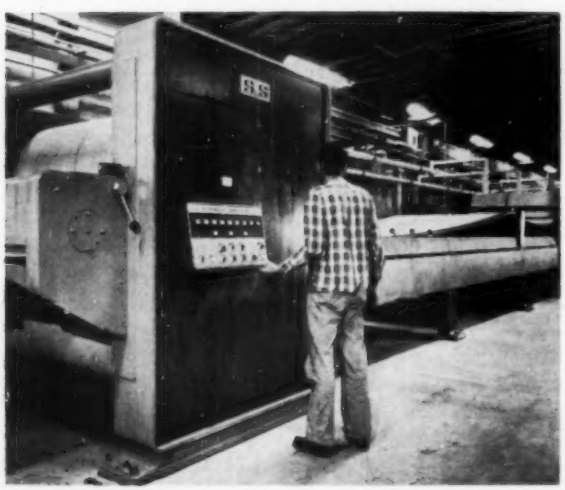
THE ENGINEERING WEEK


4 sec. warning signal (time adjustable)
Start of automatic changeover (operator depresses auto. start-button)
Corrubiner starts to slow down
Slitter indexing complete
Slitter starts to index and cutoff begins sheet length change
Cutoff sheet length adjustment complete (average 24 in. change)
Corrubiner speed slows down at rate 100 fpm/sec.
Automatic order changing cycle is now complete
Reduction gearing (10:1 ratio) engages. Old order stays at 60 fpm and new order slows down to 6 fpm. Drive starts speeding up.
Old order speeds up from 60 to 300 fpm, then slows down to 80 fpm.
Reduction gearing disengages, new order speeds up to 80 fpm.
Leading edge of new order enters cutoff. Speed up manually to operating speed at rate of 40 fpm/sec.
End of corrubiner slow-down
New order speeds up from 6 to 30 fpm then slows down to 8 fpm.
Rotary shear severs board
Corrubiner speed, ft/min.
Elapsed time, seconds

Time cycle for sequential automatic order-changer gives elapsed time of 32 seconds for a complete changeover. Dotted line indicates incoming order; shows how clutch and gearbox control its speed to the runout.

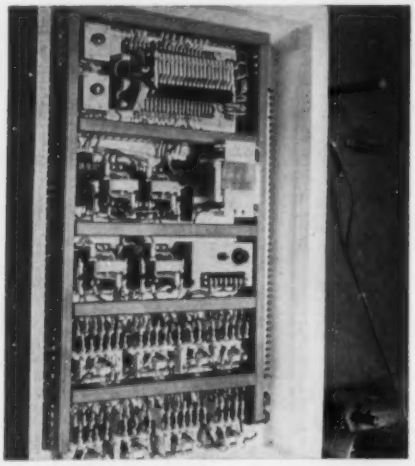
Step Switching Controls High-speed Machine

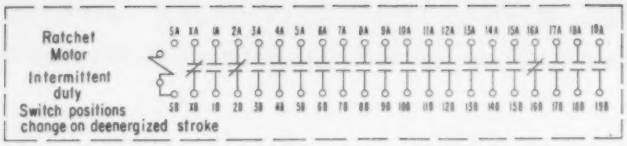


Control panel for slitter, scorer and cutoff operation is located at main belt pull roll stand of block-long paper-board machine.

NEW YORK – Automatic control entered the highly competitive paperboard industry recently when scoring, slitting and cutting of paperboard to size was accomplished without machine shutdown and with only momentary slowdown. The S & S Corrugated Paper Machinery Co, Brooklyn, NY developed, designed, constructed and installed this integrated machine at Royal Container Co's Buena Park, Calif plant.

In an industry that has conventionally improved one machine at a time, and is dominated by short-run orders, both machine- and man-hour time can be costly. This makes quick, automatic changeover and integrated lines important economic considerations. The Corrubiner–as the machine is called–brings together, for the first





X= Make
O= Break

MACHINE FUNCTIONS

Contact function	Contact number	1 Home	2 Warning signal	3 Down speed, 60 fpm	4 Shear	5 Retract, hold pressure	6 Triplex index, knife adjust	7 Down speed, 300 fpm	8 Reduction gearing disengaged	9 Step switch resets	10	11	12
Interrupter	XA-XB	X	X	X	X	X	X	X	X	X	X	X	X
Signal	1A-1B	O	X	O	O	O	O	O	O	O	O	O	O
Mor down (60 ft)	2A-2B	X	X	O	X	X	X	O	X	X	X	X	X
Shear	3A-3B	O	O	O	X	O	O	O	O	O	O	O	O
Air clutch	4A-4B	O	O	O	O	X	X	X	O	O	O	O	O
Mor up (300 ft)	5A-5B	O	O	O	O	X	X	O	O	O	O	O	O
Timer	6A-6B	O	O	O	O	X	O	O	O	O	O	O	O
Triplex index	7A-7B	O	O	O	O	O	X	X	X	O	O	O	O
Knife adjust	8A-8B	O	O	O	O	O	X	X	X	O	O	O	O
CR5 & reset	9A-9B	O	X	X	X	X	X	X	X	X	X	X	X
Clutch lamp	10A-10B	O	O	O	O	O	X	X	X	O	O	O	O
Mor up lamp	11A-11B	O	O	O	O	O	X	X	O	O	O	O	O
Triplex run jog lockout	13A-13B	O	O	O	O	X	X	X	X	X	O	O	O
CR4	14A-14B	O	X	X	X	X	X	X	X	X	O	O	O
Speed up lockout	15A-15B	O	O	O	O	X	X	X	X	X	O	O	O
AS2	16A-16B	X	X	X	X	O	O	O	X	X	X	X	X

Step-control switching (top, left) is arranged in upper bay of control box, which also contains relay and control panel circuits. Panel lights (bottom, left) show which machine function is in operation at any point in the sequence; when light goes off function is ended. Use of this heavy-duty step switch obviates a complex, multiple relay arrangement. Control position vs machine function (chart) can be varied by changing cam arrangement in step switch. Ratchet motor signals next machine function only after previous operation is completed.

time, individual machine units to form a 325-ft integrated line. And in its final operation of scoring, slitting and cutting, automatic changeover with only momentary slowdown of the high-speed flow is possible.

Step control rather than time-control switching is the answer. Step switching takes full advantage of the optimum time required for each stage of order changing. Time-controlled switching requires setting the machine for the maximum time required for any operation.

Automatic changeover works as follows: By counter or manually, the control warns when the end of the run nears, and slows the paper line from run speed to changeover speed. At the reduced speed, the paper is severed and the runout accelerated while the incoming paper is slowed by a clutch and gearbox arrangement. Then the slitter is indexed, cutoff adjusted, and the speed brought to the run speed of the new order.

The slitter is preset for the incoming order and, once indexed, scores and slits to the new size. While this order is running, scorer and slitter heads can be changed for future runs. Sheet lengths are preset on the rotary cutoff for the following run. ■

Midget Turbojet Packs Power With One-Piece Cast Rotor

DETROIT—A turbojet engine, weighing only 23 lb and delivering 85-lb thrust, is nearing production at Williams Research Corp here and will soon be available for experimental applications. Known at the WR 2-1, it upgrades an earlier model which delivered 70-lb thrust (*PE—Jan 25 '60, p 18*).

Its turbine and compressor are said to represent a significant breakthrough: rings and blades are cast in one piece from cobalt-base alloy castings. (Chrysler also produces a cast rotor, but is said to use an iron alloy.) Elongation and plastic flow of the casting are prevented by introducing compressive stresses in the machine weld where ring connects with the forged hub.

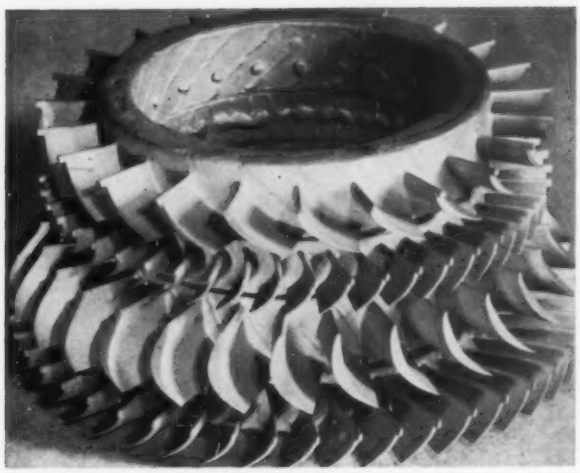
President of the company, Sam B. Williams, says that one of these castings costs about $80 in prototype quantity. He predicts cost will drop to about $10 with volume production, adding that the usual "fir tree" type blades and rings cost 10 times as much and are generally made from less commonly available materials.

The compressor's housing assembly consists of three simple castings with the third superimposed over the second. The hot section is a vacuum-brazed assembly made of 18-8 sheet-metal capable of withstanding 1330-F exhaust temperatures. In the usual aircraft turbine technique, this assembly is hand-welded.

Combustion chamber of the Williams engine is annular and handles an air-flow rate of 1.75 lb/sec. It is expected to consume about 1 lb fuel/hour at rated power and 59,000 rpm.

The WR 2-1 turbojet was specifically designed for aircraft use. Most likely applications will be to power a new generation of tiny, near sonic speed drones. The company is also installing

ROTOR ASSEMBLY for Williams Research Corp turbojet consists of a relatively long shrouded inducer, a centrifugal compressor, and a single-stage axial turbine.



BLADE RING CASTINGS for the WR 2-1 engine come from the foundry this way. Close tolerances keep machining to a minimum.

a free-shaft version in the army's Mutt (a ¼ ton utility truck) for evaluation. This type, Williams feels, may also appeal to prestige-conscious buyers of deluxe small cars.

In addition, the company has built several similar engines equipped with regenerators (rotating heat exchangers) for Outboard Marine Corp. Eventually, 125-hp versions may be used in Navy personnel launchers.

The rotating heat exchanger consists of several layers of crimped stainless steel, wound on a hub much like a roll of tape. The steel is about the thickness of this page, but crimping produces air passages 6 to 8 times larger. The highly proprietary pattern of the crimp is critical to efficiency. It is produced by a Williams-designed and-built machine that, says Williams, caused as many headaches as design of the heat exchanger itself.

When turbine is operating at its peak of 59,000 rpm, the exchanger is turning at only 60 rpm. Cold incoming air passes through about one-third of its area, where it is heated by the exhaust gases that are passing through the other two/thirds. This added heat greatly increases efficiency, especially at low loads.—**Don MacDonald, Detroit News Bureau**

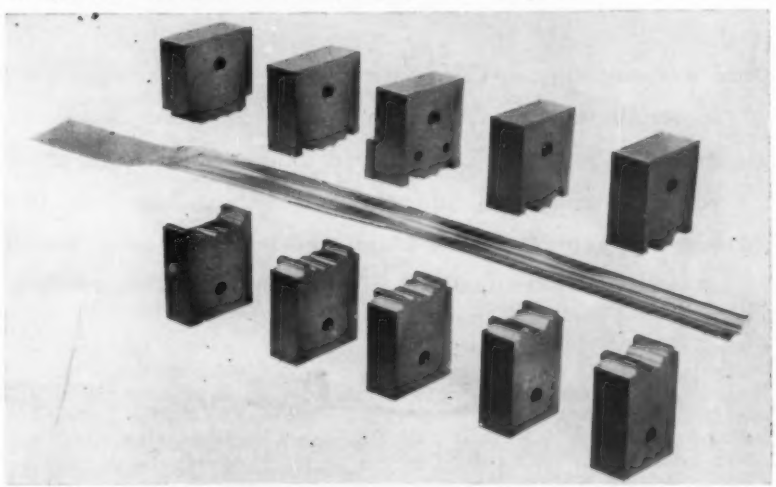
Revitalized Council Takes Firm Control of US Space Programs

WASHINGTON—The new Space Council, under chairmanship of Vice-Pres Lyndon B. Johnson, is becoming the dominant voice in space matters. Congress had hardly okayed legislation allowing him to act as chairman, in place of the President, when the organization was handed its first major task—to review the nation's space program and report back on ways to speed it up.

Johnson personally took command of a series of meetings with top space groups to hammer out a speed-up program. He called in the Secy of Defense, top officials from NASA and AEC, and a host of others including rocket expert Wernher von Braun.

This beef-up is just the beginning of the council's activity. When Congress shifted chairmanship, it also trimmed membership from 9 to 5. Gone are three members selected from industry. A permanent staff is being formed for the council too. ■

Inexpensive Way to Get Intricate Metal Shapes



These five dies do the trick in a new Prontour process for converting strip metal into complex shapes. They are arranged here in pretty much the way they are used. Metal strip, passing between them, is progressively shaped to the silhouette on the mating die faces through vibratory press action. The process is said to be particularly adaptable to prototype or short runs where such mass production methods as roller, extrusion, brake-press and draw-bench dies are expensive and time-consuming. According to developer of the process, Prontour Co, Cleveland, a wide variety of intricate shapes can be obtained. These include shallow flanges, small curls, short legs, etc. Straight sections of any length and rings or ring segments can also be formed.

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Off-shelf Parts Give 3-D Monitor for Aircraft

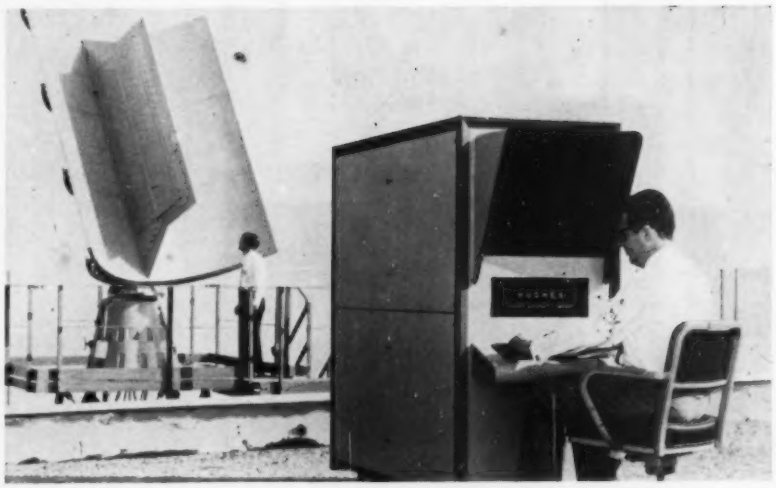
FULLERTON, CALIF.—Following up its development in 1957 of 3-D radar, Hughes Aircraft has now designed a stereo viewing system. It enables a single monitor to determine altitude, direction and range of moving aircraft. Known as Stereoscan, the system has been assembled from relatively inexpensive off-the-shelf components at Hughes.

Basic to the system is the 3-D radar, which Hughes developed for Navy and is already mounted on many guided-missile carriers. Though security restrictions prevent Hughes from describing details of this radar, company engineers say that bearing and range information is obtained by mechanically rotating radar antenna; altitude is obtained by electronically stepping a radio frequency up or down along the center ridge in the antenna's cylindrical disk.

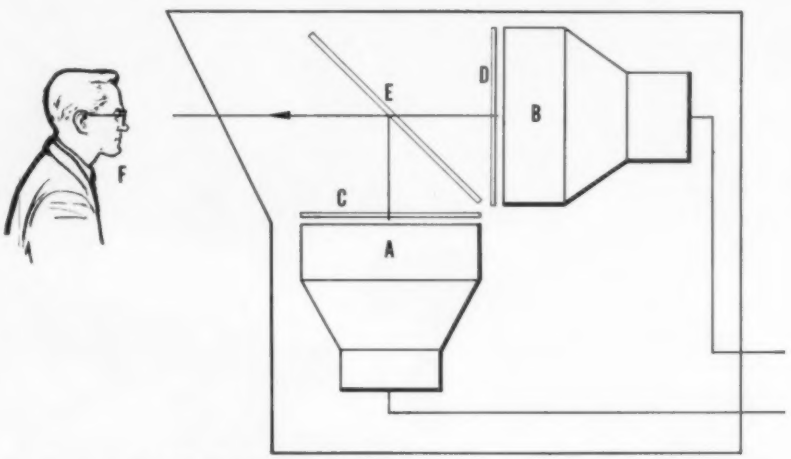
Generally, this data on bearing and altitude is independently displayed on two screens side by side. Two observers working together then determine the position of the aircraft in space. With the new Stereoscan system, a single piece of equipment enables one observer to do the job.

To achieve a unified 3-D image, Hughes engineers have arranged the screens at right angles with a mirror between (see chart) so that the two screens appear superposed on one another. Light from both is polarized and the observer wears polarized glasses; he sees one screen with the right eye, the other with the left. When visual parallax is then introduced into the display of each tube, it produces a corresponding change in the convergence angle of the eye. The viewer mentally interprets these as changes in depth.

For the viewer to interpret depth accurately, aircraft echoes, appearing on the radar screens, must be written with an amount of parallax proportional to the height of the aircraft. The echos are transmitted to the screen in time-varying voltages proportional to the sine of the antenna's elevation angle. By adding this voltage to the deflection voltage of one tube and subtracting it from the other, visual parallax proportional to target height is obtained.



EQUIPMENT FOR VIEWING airplane movements in 3-D includes radar (rear) and stereoscopic display unit (foreground).



SIDE VIEW OF 3-D STEREOSCOPIC display shows the two 21 in.-dia-Tonotron tubes (A & B) at right angles to one another. Half-silvered mirror (E) positioned at 45° to tube faces makes the two images appear to coincide. Polaroid filters (C, D, F) cause viewer to see one tube with the right eye, other the left, to add depth perception.

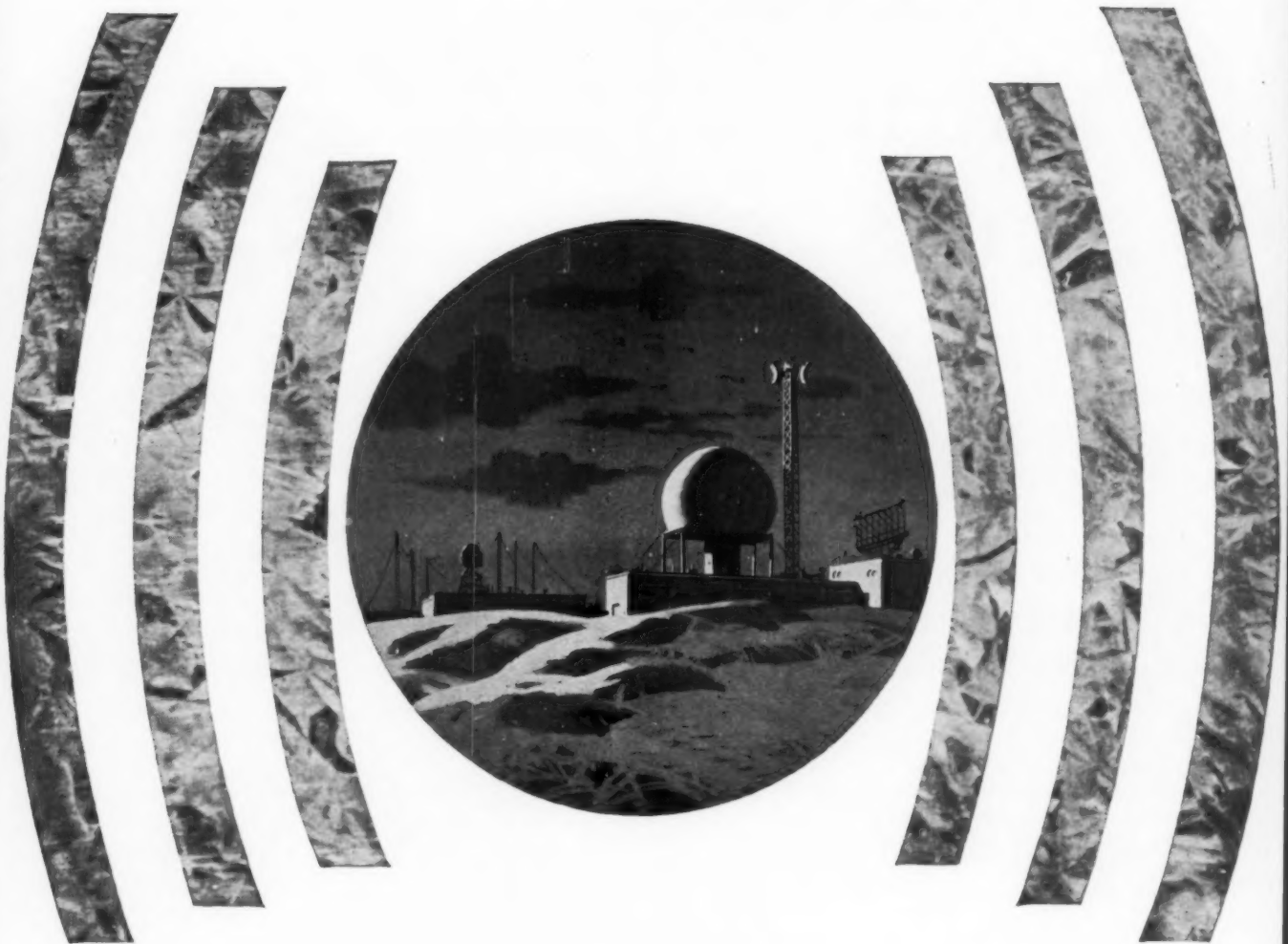
For its Stereoscan system, Hughes has replaced the usual cathode ray tubes with two direct-view storage display tubes. Known as Tonotrons, they have the advantage of retaining an image of a moving target for a time. This trail makes it easier to plot direction of the target and determine the difference in altitude between two moving objects. Image-storing capability is derived from mesh located just behind the coated face of the tube. The electron beam must pass through this mesh before an image can be formed on the screen. In passing, the beam charges the mesh, thereby prolonging its screen image.

To an observer, the image appears to have depth of about 1 ft. In actuality this represents 50,000-ft altitude or more. As now designed, the screen can be adjusted to focus on any chosen altitude—i. e., it may simply search from ground to 1000 ft. The trails of climbing or spiraling planes within this block of air are sharply delineated, looking almost like forms cast in a plastic mold. If traffic density leaves a confusing array of trails on the screen, the operator can erase them by pushing a button which discharges the mesh.

Hughes says it developed the radar viewer entirely on its own, and estimates a cost less than $100,000.

—William Wallace, Regional Editor

U.S. Air Force DEW-Line buildings fend off corrosion . . .



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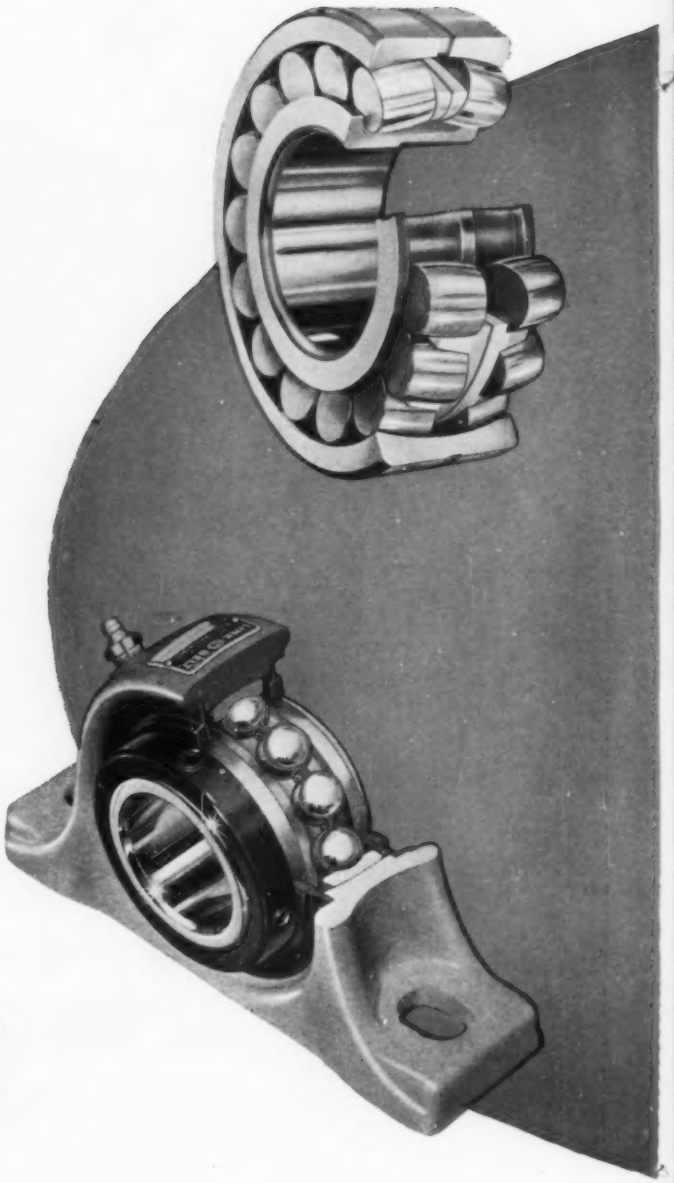

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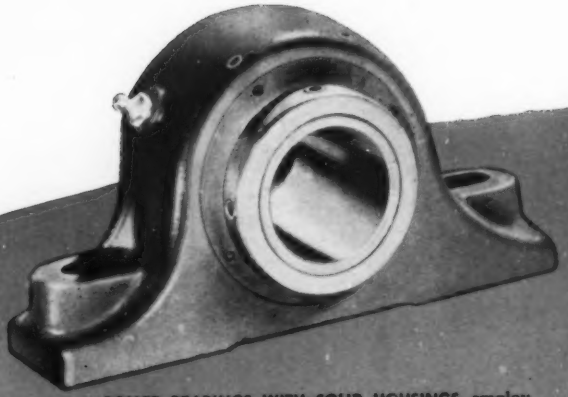
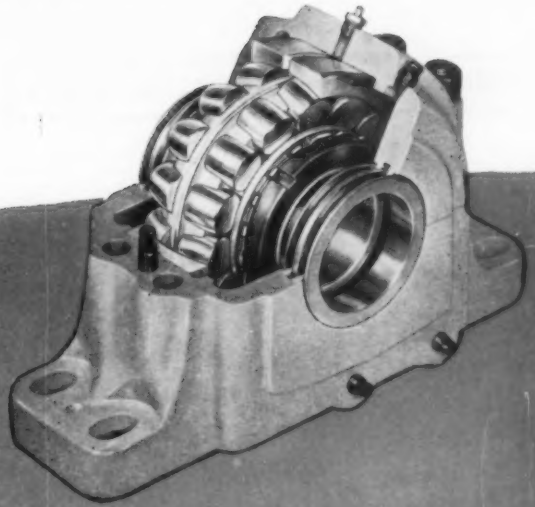


ROLLER BEARINGS WITH SOLID HOUSINGS employ heavy-duty, double-row self-aligning roller bearings. Available with cast iron or cast steel housings. Choice of seals to match operating conditions. Compact, rugged and easy to install. Series 400, for ¾" to 4" shafts.



SPHERICAL ROLLER BEARING PILLOW BLOCKS feature Link-Belt's *new Spherical roller bearings* in sturdy cast iron or super-rugged cast steel housings. Designed for either adapter or direct shaft mounting. Choice of rugged steel multi-labyrinth or Dacron contact seals. For shafts from 1 7/16" to 10½".

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BALL BEARINGS WITH SOLID HOUSINGS feature self-aligning, single row, deep groove ball bearings. Precision balls operate on honed raceways assuring smooth, quiet operation. Spring locking collars simplify installation . . . lock bearings securely to shaft. One piece housings are compact, require minimum support space. Series 200 and 300, for ½" to 4" shafts.

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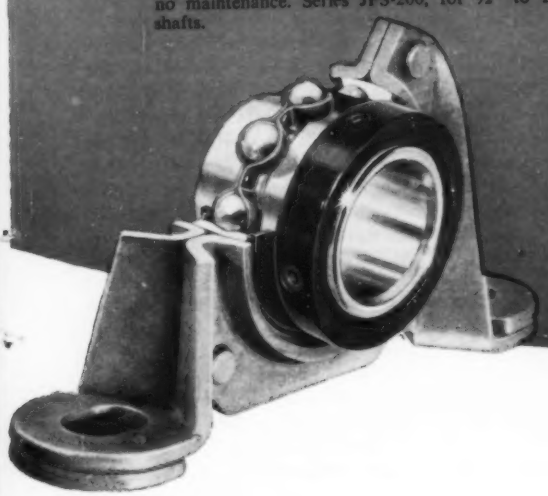
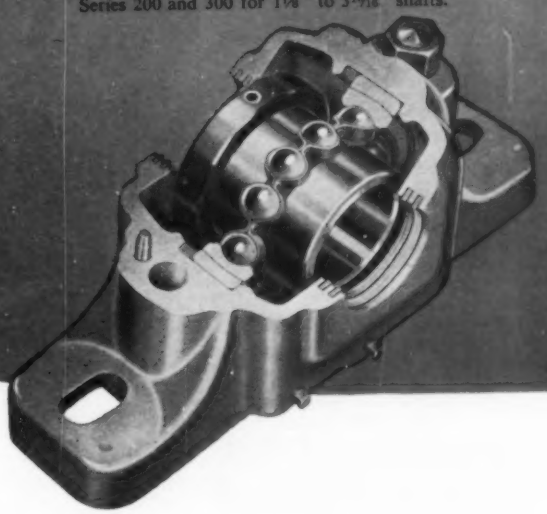
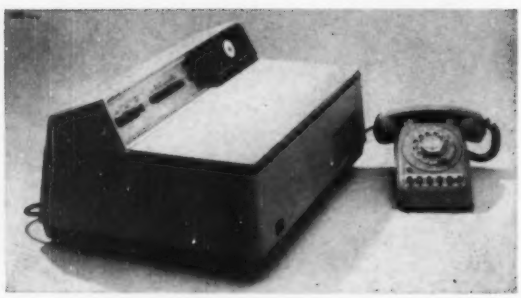
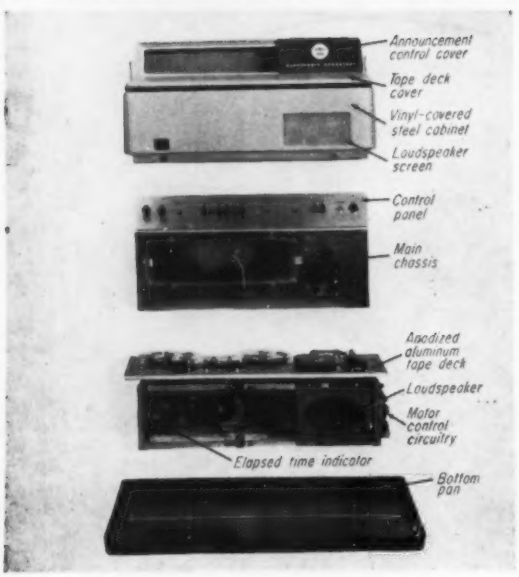


BALL BEARINGS WITH TWO-PIECE HOUSINGS provide ease of installation, simplify bearing and lubricant inspection. Large reservoir for oil or grease makes them ideal for high speed applications. Bearings are self-aligning to compensate for shaft misalignments. Series 200 and 300 for 1⅛" to 3 15/16" shafts.





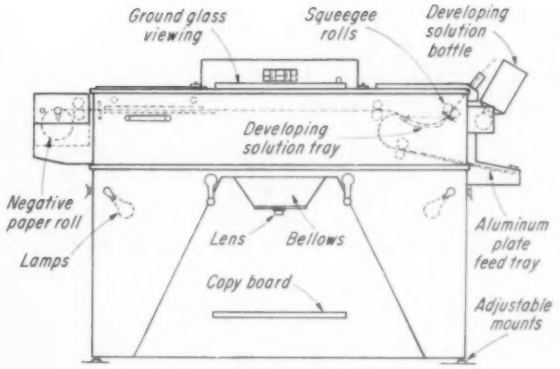


TELEPHONE ANSWERING SET (above, left) required complete redesign because 45-rpm record player unit in the former model (above, right) was discontinued. Also, the development of transistors and printed circuitry made possible new approaches to this type of equipment.

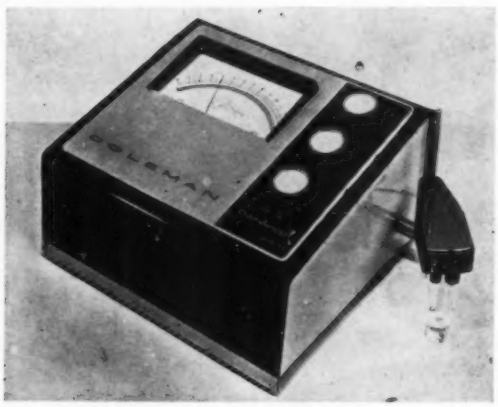
After a briefing by the engineering staff of Electronic Secretary Industries Inc, Waukesha, Wis, Raymond Loewy-William Snaeth Inc, New York industrial designers, mocked up each of the major components and assemblies (transport mechanisms, motor, switching apparatus, circuit boards, etc.) in cardboard to study in three dimensions the most satisfactory arrangement for consumer use, manufacturing and assembly, and servicing. Sketches were made throughout this process to study cabinet proportions, assembly and construction.

As a result, the new model's two tape recorders (one for subscriber's outgoing announcement, the other for caller's messages) are arranged end to end—rather than side by side, as in the former version. This allowed decreasing the front-to-back dimension, with only a small increase in width: a proportion more suitable for use on desks and shelves.

The swing-up lid protects the tape deck while leaving the pushbuttons needed to play back incoming calls readily available. The small door at right end of control panel prevents use of recording section by unauthorized persons. The entire unit is sectionalized for simpler assembly and maintenance (left). Access for servicing is through a removable back panel.



CAMERA-DEVELOPER photographs original material on aluminum plates for photo-offset printing and then develops plate in its own self-contained solution tray, all at the push of a button and in less than 2 min. Comparable systems are limited to paper plates (less durable) and consist of two or more manually operated units, some of which require skilled operators. Made by A B Dick Co, Chicago, camera will also reduce original as much as 50% or enlarge it to twice original size. The whole machine requires only 22 sq ft floor space, exhibits an efficient arrangement of dials, cranks and other controls. Yet the housings, which cover paper, developing materials and aluminum plates, look "hung on"—as though this was a second or third-generation model, rather than completely new.



ELECTROMER (above) for determining pH of solutions in clinical and industrial analytical laboratories, is based on a zero-drift dc amplifier with built-in temperature-compensating system. Incorporated in the new design (old version at right) is an up-to-date eyeletted circuit board, in place of former point-to-point wiring. Wrap-around sheetmetal housing was proposed by the designers to avoid the relatively high tooling charges that would have been entailed if the new design had required molded phenolic plastic, as did the earlier instrument's. Access to chassis in new model only requires removing knobs and rubber feet and lifting wraparound up and back. Controls have been relocated, with the most frequently used at the bottom. This permitted a larger, better positioned dial. Spillage is a constant threat to instruments of this kind, the reason why holes for control shafts are sealed with raised gaskets, which the knobs completely cover when installed. Manufactured by Coleman Instruments Inc, Maywood Ill. Industrial designers: Palma-Knapp, River-Forest, Ill.

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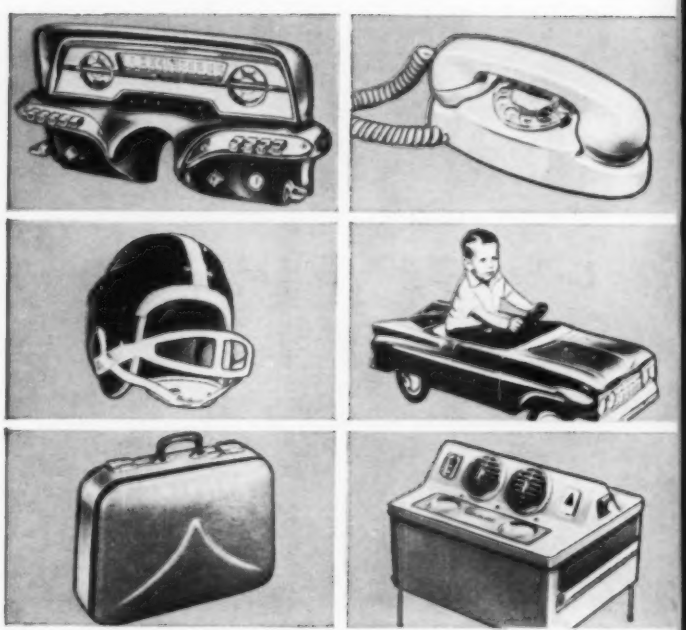

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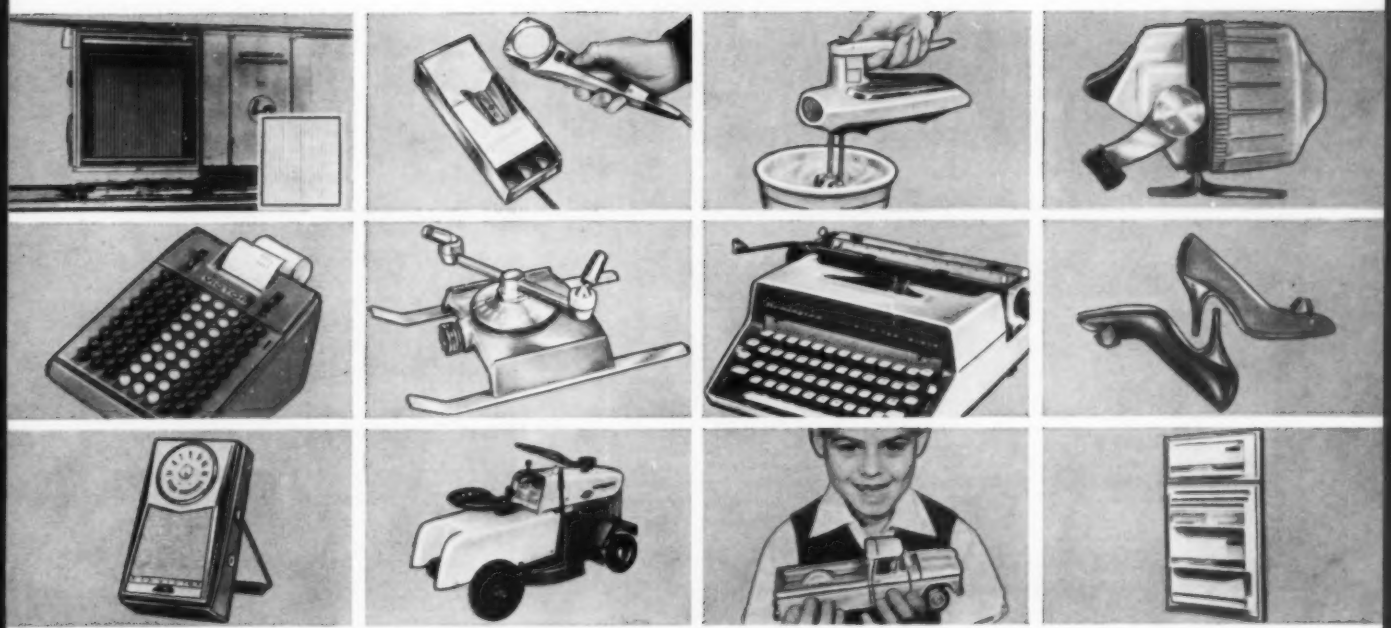

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READER TO EDITOR

That Glass Controversy

To the Editor:

Re: the letter, "Which Glass Is Safest?" by H G Brown Jr, Apr 17 issue, p 28. I witnessed an accident involving a 1961 Volkswagen equipped with the "hardened glass" and saw that even though the passenger's head went through the windshield completely, powdering it, the result was nothing more than a bruised forehead. Compare this with the hundreds of similar accidents involving "safety glass" and its disfiguring and sometimes fatal results. Let's ask the people who will carry the scars for life whether the laws should be revised to protect the passenger instead of the glass manufacturer. I'm all for you and Dr Goddard.—MALCOLM R HATHAWAY
Plattsburgh Div,
Imperial Color Chemical & Paper

To the Editor:

I read with considerable interest Mr Brown's letter defending "required by law" laminated glass against attacks by proponents of hardened glass (also "required by law," but not in countries where DuPont occupies a dominant industrial position).

I have had little personal experience with either type glass, except when, as a young man, I piled up my new '41 Ford and mildly fractured my head on the windshield. In WWII, however, I had occasion to see the effect of small arms fire on both types of glass. My own GMC 6 x 6 had to be driven by leaning out the side after suffering one bullet through the upper left corner of the windshield.

The German vehicles, when hit in the windshield, filled the driver's lap with broken bits of glass without sharp edges. There was no impairment of vision, because the whole thing collapsed right out of the frame.

Of course, both types of glass in those far-off days were optically superior in their undamaged state to any windshield currently available. Oddly enough, they were also cheaper and widely available. They were flat. —JOHN H MILBOURN
Seattle, Wash

To the Editor:

I have personally observed from my own experiments with hardened glass that: (1) it will not crack, but rather breaks into grains like coarse sand, without large pieces; (2) the grains do not have sharp cutting edges, but can be rubbed between one's hands without injury; (3) one cannot break even a small piece or chip from a sheet of hardened glass without causing the whole sheet to disintegrate into sand—therefore it would be impossible for one's head to make a hole in a window—rather, the whole window would disappear; and (4) hardened glass is far stronger than laminated or plain glass—I have seen it clang onto a concrete floor like sheets of steel, without breaking.—R A GERLITZ
Chief engineer
Propellair, Springfield, Ohio

• Currently, the Automobile Manufac-

turers Assn and other groups are undertaking comparative research of the two types of glass, but no results have been reported. Previous research in Europe favors tempered glass while that in this country favors laminated glass. Arguments in favor of the laminated glass by American engineers are that it is not subject to occlusion or crazing when struck by a flying object, and that it is somewhat easier to replace. Several automobile companies, however, are now using tempered glass everywhere except in the windshield, because no clear safety decision can be made between the two types on the basis of present information, and the tempered glass saves about $10 per car. Standard American laminated glass could be made stronger by increasing the thickness of the 15-mil plastic laminations and possibly by research to improve the plastic—EJT

Unreliable Witnesses

To the Editor:

Your report in the Apr 10 issue, p 15, on the FTC vs Evis is disturbing in its indication that the court placed more confidence in the testimony of prejudiced laymen than of unprejudiced experts. An experience I had many years ago indicates the unreliability of witnesses when they are testifying to something they want to believe. I was employed by a manufacturer of radio-interference filters which, to be effective, must be attached to the electrical apparatus that is creating the interference-producing impulses. I had demonstrated a variety of filters, by applying them to radio-interference sources, but the customer wanted something he could attach to his radio receiver. He ignored the evidence of my demonstrations and insisted on buying a filter to instal between this radio set and the ac outlet, even though a test showed that the filter did absolutely no good.

If this man had been called to testify, he would probably have sworn that the filter in the power line was helping him get better reception—because that is what he chose to believe. So much for consumer testimony! —C. W. METCALF

Engineered Advertising
Sharon, Mass

COMING EVENTS

MAY

14-17 . . . . National Fluid Power Association, 1961 Spring Meeting, The Greenbrier, White Sulphur Springs, WVa

22-25 . . . . American Society of Mechanical Engineers, Design Engineering Conference & Show, Cobo Hall, Detroit

22-26 . . . . American Society of Tool & Manufacturing Engineers, 1961 Convention, Statler Hilton Hotel, NYC

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Which coupling cuts costs?

All of Waldron's many types will reduce maintenance and operating costs, and Waldron's engineers will help you specify the best one for your power transmission, whether the drive is big or small.

Type	Bore	Max. torque inch-pounds	Max. rpm
Standard Gear Series A	½ to 7½	716,310	12,000
Francke Pin Type	⅝ to 10½	567,000	4,000
Nylon Gear Series M	½ to 2	2,200	5,000
All Nylon Series J	⅜ to ¾	100	10,000
High Speed Series HS	½ to 8	1,197,000	70,000
Cutout Coupling Anchor-Waldron	½ to 2⅝	5,200	3,000
Cutout Pulley Anchor-Waldron	⅝ to 2⅝	17,500	2,400
Heavy-Duty Gear	4 to 13	2,520,000 5,000,000	St'd 2,000 Forged 4,000
High Misalignment Series X	1 to 6	400,000	6,500

This is merely a sample of the Waldron line, which also includes mill motor, floating shaft, Jordan, shear pin, vertical, spacer, oil collector, marine, brake wheel, and continuous lubrication types. Write for catalog or data sheets on the types you are considering.

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a division of Midland-Ross Corporation MR

It is noteworthy that more and more McGill bearing users are those who have revised their specifications on existing products to include McGill bearing design and performance advantages. Perhaps you have just switched to McGill — to the GUIDEROL series or to the new CAGEROL cage type needle roller bearing. Wouldn't it logically follow that you could be served even better by matching the best product and bearing design capabilities in the early development stage. Here McGill engineers can offer their experience with thousands of successful applications when it can be most easily applied to your new designs and your plans for increased product performance. It would offer further time and cost advantages. Most important, it is your best assurance that our extensive bearing research will complement your long range product development more specifically. Ask for McGill recommendations so that details can be worked out together.

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in today's specifications

McGILL® BEARINGS

in tomorrow's product development

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GUIDEROL® BEARINGS

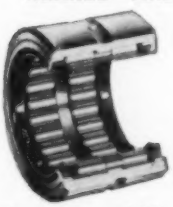
MT SERIES

Here is a compact bearing with high load-carrying capacity. Its full complement of race-width rollers is guided by an integral rail in the outer race bore, providing strength and skewing limitation that prevents binding under controlled misalignment. Rollers are guided at any operational angle from horizontal to vertical — self-cleaning through open ends. Available with or without separate inner ring in shaft sizes from ½" to 9¼". Dimensionally interchangeable with ordinary heavy duty needle bearings.

CT SERIES

Offer full type roller bearing capacity dimensionally interchangeable with ball and cylinder roller bearings of single and double row dimensions. The inner ring may be eliminated for further reduction of radial space.

SEALED—AND STILL COMPACT



No extra axial space needed for the sealed SG series GUIDEROL bearing. Seals are press-fitted securely in the outer race bore to provide the same width and performance advantages of standard GUIDEROL bearings. Contaminants are locked out, lubricants sealed in for those hard to re-lubricate applications. The SG series solves the problem of too-expensive auxiliary sealing assemblies.

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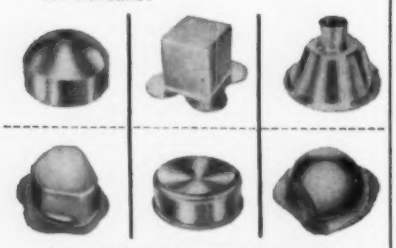

Closest tolerances adhered to in all metals, including MU METAL, BRASS, INCONEL, ALUMINUM, COPPER, CARBON STEEL, STAINLESS STEEL, NICKEL, MAGNESIUM, TITANIUM, SILVER, SPECIAL ALLOYS, HAYNES STELLITE.

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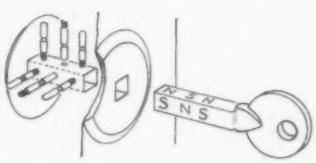
METAL CRAFTSMEN
SINCE 1924

WHY DON'T THEY R&D..?

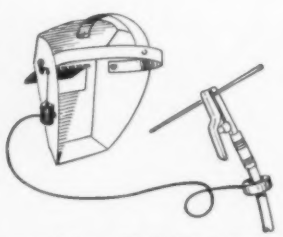
. . . wall switches that control 110-v outlets in the home by remote control. Wall switches are commonly connected so that they control one of the outlets in a room but it is often desired to change the switch to control another outlet . . . possibly even in another room. Also, clock radios can be made to turn on a coffee maker or toaster—but who makes coffee at bedside . . . or sleeps in the kitchen?

Or how about a switch by the telephone that would turn off radio or TV? At present, all these applications demand rewiring the house—usually too expensive to be practical. Wall switches (and other switches) might be made to control any desired outlet by adding a small transistorized tone-generator to the switch. These would be made in a variety of different tones and would transmit throughout the house wiring by carrier current. A tuned reed and latching relay at the outlet would respond only to the tone generated by the switch that controls it. Transmitters and receivers would be made up in matched sets—simply plug an "A" type transmitter into the socket provided in the switch, and an "A" type receiver in the junction box of the outlet to be controlled. Such a transmitter and receiver pair could probably be made to sell for less than $20—much less than cost of rewiring. —R Marie



. . . a lock with a magnetic key. New magnetic materials with high coercive force permit design of magnets with many poles in a small area. A completely weatherproof and virtually pick-proof lock could be made by substituting a magnetic bar for the conventional key. The bar would have a series of poles along its faces and these would attract (or repel) steel pins encased in the lock. Lubricated with a dry lubricant, the lock could be completely sealed. Because of the high coercive force, "permanence" of magnetization is protected from most demagnetizing fields. —I Brema

. . . a projector that accepts photographic negatives and shows a positive image on the screen. With this device, negatives would be equivalent to positives and could be projected like 35mm slides. The conversion could be done electronically with scanner and pickup tube. This signal would then be fed to a conventional TV set. But this is too bulky, costly and complicated. Needed is a simpler way—without all the electronic gadgetry. C Perko



. . . a welder's mask with an automatically controlled window that gives a clear view of the work before the arc is struck. This might be done several ways. Simplest: the window would be covered by a shutter made of the near-opaque filter glass normally used in masks. The shutter, operated by a solenoid, would be open except when current flowed in the welding cables. This flow could be sensed by a Hall-effect device clamped around the cable. This, in turn, would be wired to the solenoid. Or, the window might be a variable-density device similar to the lenses devised for photographing atomic explosions. In either event, the window would allow the welder an unobstructed view of the work without need to flip his face shield up and down. —R R Rader

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors long worthwhile paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who have a fresh viewpoint or more time to experiment. We pay $10 for each one accepted.

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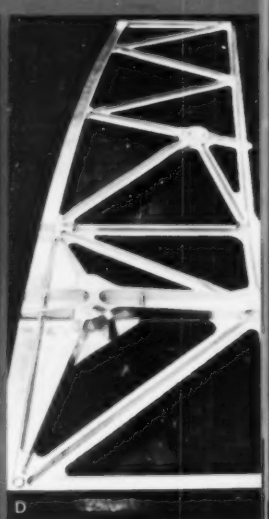
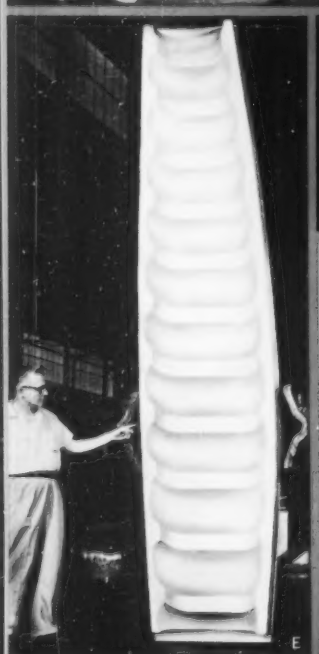
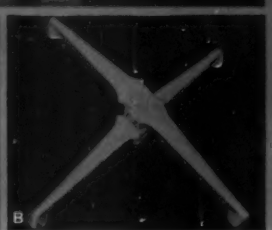
FORGINGS

HERE ARE A FEW ALCOA FORGINGS... BOTH TYPICAL AND UNIQUE...THAT MAY INTEREST YOU:







A. Tube 100 in. long and 40 in. in diameter, with stepped internal contour.

B. An aluminum forging answered both aesthetic and practical requirements in this chair base.

C. Tapered rings. Alcoa can forge them in diameters over 8 ft.

D. Aircraft nose wheel-well truss.

E. World's heaviest closed die forging, 156 in. x 36 in. x 12 in., weighs more than 3,000 lb.

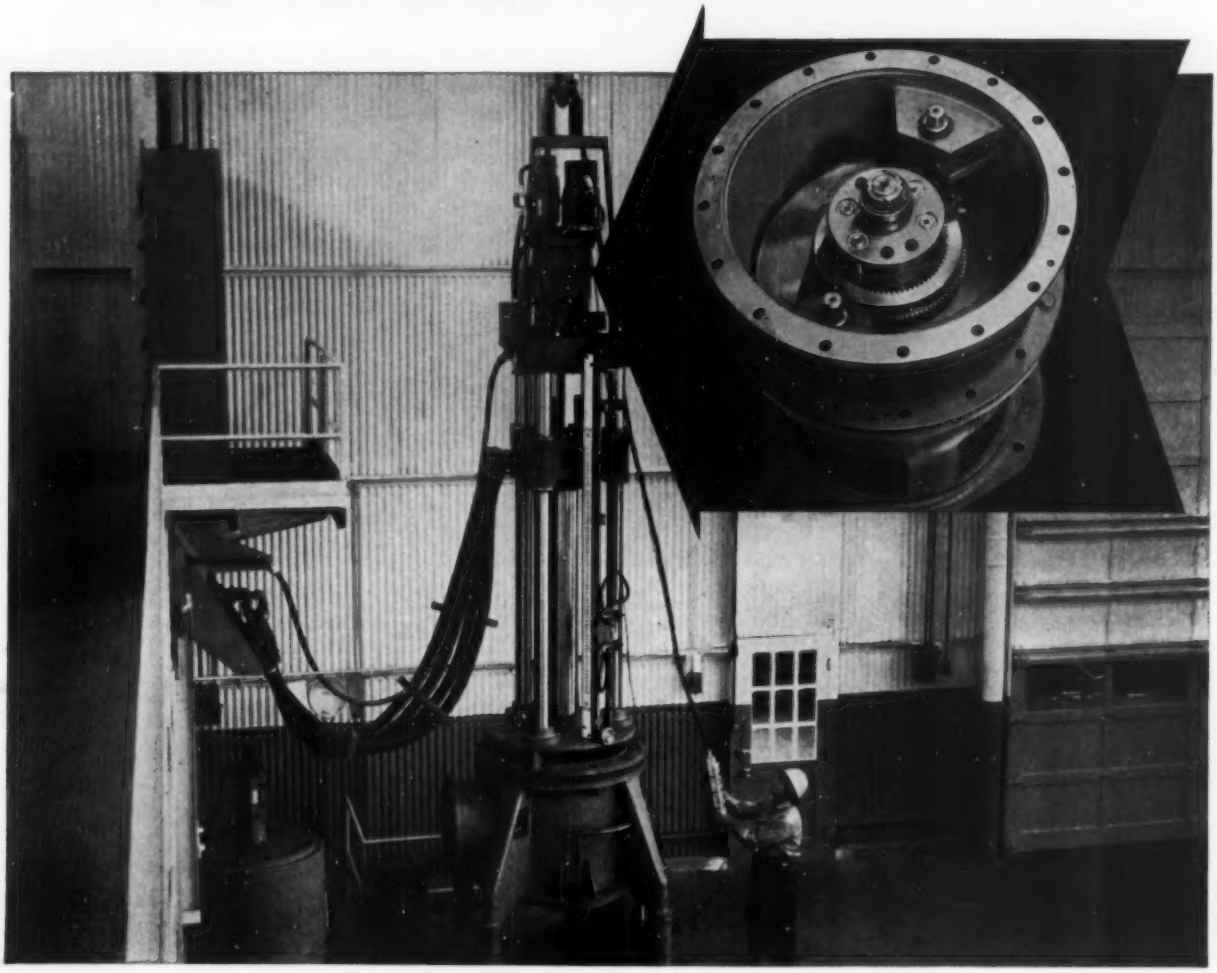
F. Hinge for rear door of truck trailer.

G. Alcoa Forged Disc Wheel, highest quality truck wheel on the market.

H. Stress-relieved hand forging in "hockey-stick" shape for jet aircraft.

I. Believed to be the longest closed die forging ever made, this wing spar measures nearly 23 ft.

Philadelphia Precision Ground Gearing Increases Sensitivity of New Vacuum Arc Furnace



Philadelphia precision ground gearing is responsible for smoother, more efficient operation of a new consumable electrode vacuum arc melting furnace installed at Standard Steel Works Division of Baldwin-Lima-Hamilton Corporation.

This specially designed differential reduction, planetary gear drive greatly increased the efficiency of the furnace. The old problem of stop-start action with uneven electrode burnoff has been completely eliminated. Now, uniform electrode feed permits arc voltage to be maintained within ±.1 Volt. Electrode burnoff is uniform.

This drive problem is typical of hundreds that have been solved with Philadelphia hardened, precision ground gearing . . . problems where improved gear accuracies have resulted in space and weight savings, higher-speed operation, reduced sound and vibration levels, and longer gear life—all at no increase in cost.

Our experienced engineering staff, specialists in all types of power transmission problems, make sure that proper design and materials combine to meet your most exacting needs.

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This exceptional vinyl can be laminated permanently to metal for an integral finish of distinctive color and design! That's its beauty as a selling plus. And here's its beauty from a *production* standpoint: It can be cut, crimped, drilled or deep-drawn without impairing its beauty or distorting the material. No new processing equipment needed. Enables you to work with prefinished parts. Can even eliminate the need for spray booths and baking ovens. Cleans easily. Write for information and samples.

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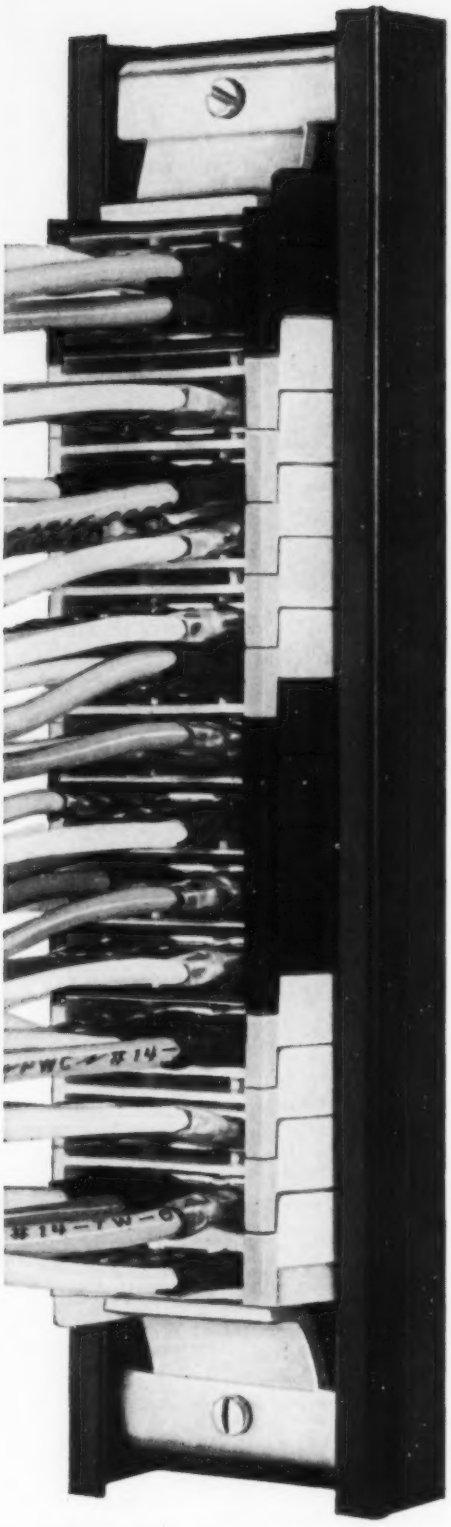
Masland Duran
CLAD
vinyl finish

Furniture by FALCO PRODUCTS CO., Philadelphia, Pa. Masland Duran Clad used on table. Matching upholstery grade Masland Duran on chair.



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THE ONE-TRACK MIND OF TERMI-BLOK*

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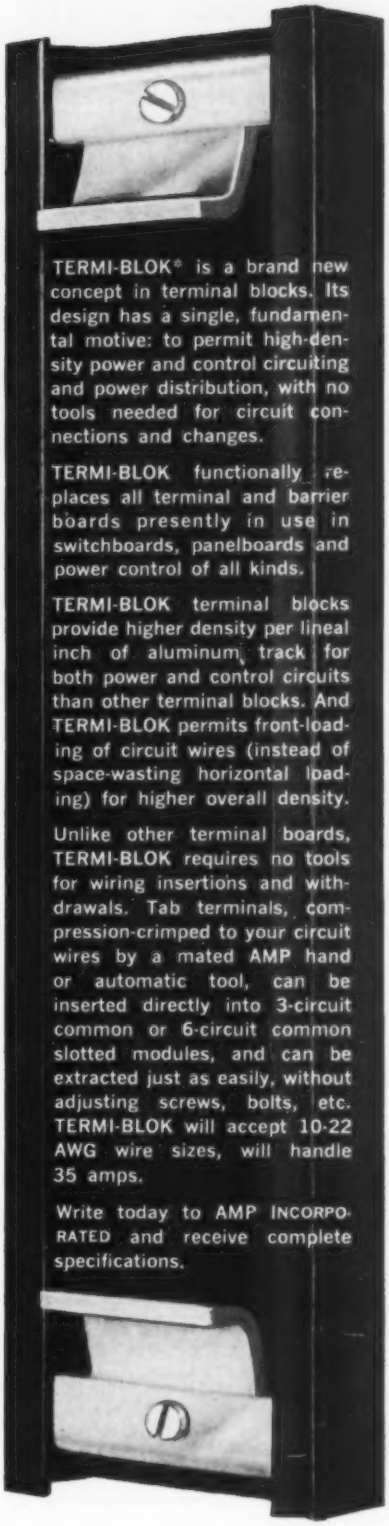

TERMI-BLOK* is a brand new concept in terminal blocks. Its design has a single, fundamental motive: to permit high-density power and control circuiting and power distribution, with no tools needed for circuit connections and changes.

TERMI-BLOK functionally replaces all terminal and barrier boards presently in use in switchboards, panelboards and power control of all kinds.

TERMI-BLOK terminal blocks provide higher density per lineal inch of aluminum track for both power and control circuits than other terminal blocks. And TERMI-BLOK permits front-loading of circuit wires (instead of space-wasting horizontal loading) for higher overall density.

Unlike other terminal boards, TERMI-BLOK requires no tools for wiring insertions and withdrawals. Tab terminals, compression-crimped to your circuit wires by a mated AMP hand or automatic tool, can be inserted directly into 3-circuit common or 6-circuit common slotted modules, and can be extracted just as easily, without adjusting screws, bolts, etc. TERMI-BLOK will accept 10-22 AWG wire sizes, will handle 35 amps.

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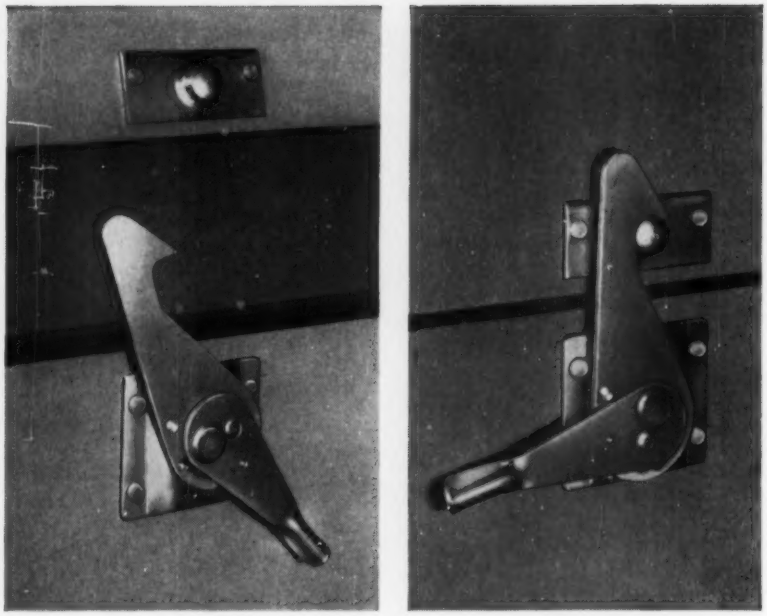
WHAT HOOK-LOCK IS

HOOK-LOCK is a springless, positive-locking latching device which is ideally suited for use on rigidly specified military transit cases as well as less expensive commercial containers. It provides high closing pressure and tremendous load-carrying capacity...is impact and shock-proof. HOOK-LOCK is so designed that it lies flat against the mounting surface whether in open or closed position. Since operation is parallel to mounting surface, no space for operating clearance is required.

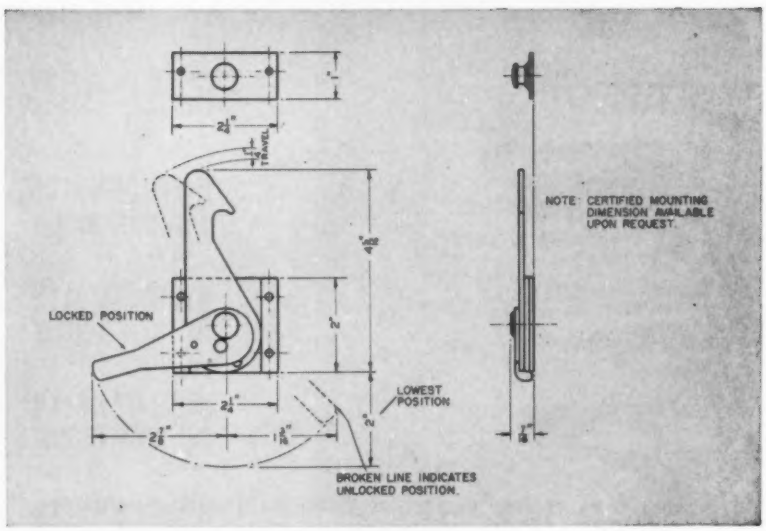


HOOK-LOCK lies flat against mounting surface, open or closed.

New—HOOK-LOCK container latch...It's flat!

FEATURES

- Shock-proof—solid construction...withstands high impact blows *directly on the fastener.*
- Closing pressure of 200 lb. Where needed, pull-down pressure can be substantially increased by modification of operating lever.
- Tensile load capacity: 750 lb.
- Compact—lies flat open or closed. Extends just 7/16" from container surface at thickest point.
- Positive-locking and springless. Unaffected by arctic temperatures.
- No operating clearance required, because hook and lever move parallel to mounting surface.


LOCKED POSITION
LOWEST POSITION
NOTE: CERTIFIED MOUNTING DIMENSION AVAILABLE UPON REQUEST.
BROKEN LINE INDICATES UNLOCKED POSITION.

IF YOU have questions regarding the possible application of HOOK-LOCK or other Simmons industrial fasteners to your particular needs, your inquiry will receive our immediate attention. Contact your nearest Simmons office or write direct.

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TWICE as many Timing Contacts

—SAME PANEL SPACE!

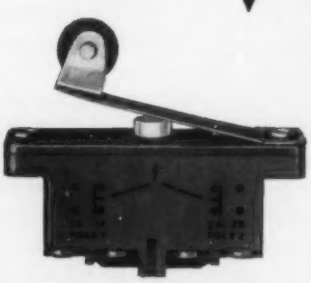
For extra timing contacts, it's no longer necessary to buy a second timer or extra relay. Square D's Class 9050 Types B and C timing relays are now available with the new 2-pole snap switch which doubles the number of contacts you get with the single-pole device—and mounts in exactly the same space! What's more, totally enclosed contacts eliminate dust and dirt problems.

The 2-pole version also offers the same advantages as the single-pole timer:

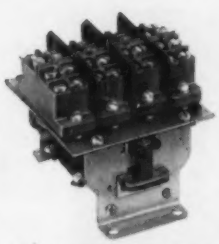
- Easily converted from on-delay to off-delay or vice versa
- One or two single-pole double-throw instantaneous snap switch interlocks
- Timing period adjustable from 0.2 seconds to 3 minutes
- Available for either AC or DC
- All contact terminals out front for easy wiring
- Wide variety of enclosures for any application

Class 9050 Type B Timing Relay with 2-pole snap switch

ALL THESE DEVICES NOW AVAILABLE WITH 2-POLE SNAP SWITCHES



Basic 2-pole snap switch available, or with a variety of operators



Type P relay offers 16 contacts (8 N.O. and 8 N.C.) in one compact unit occupying less than 14.5 square inches of panel space

Limit switch is the most oil-tight of any you can buy

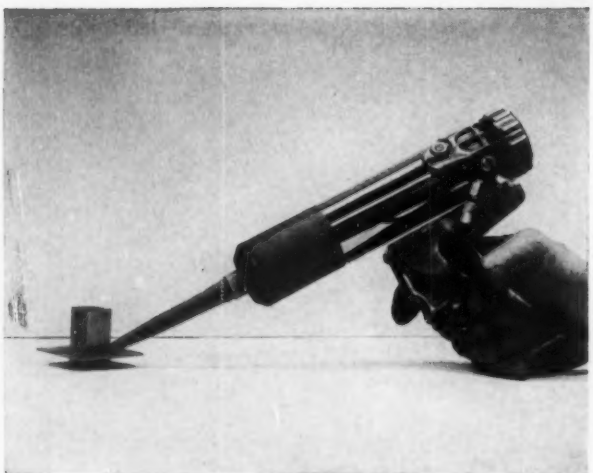
Industrial-type pressure switch offered with operating range to 15,000 lbs

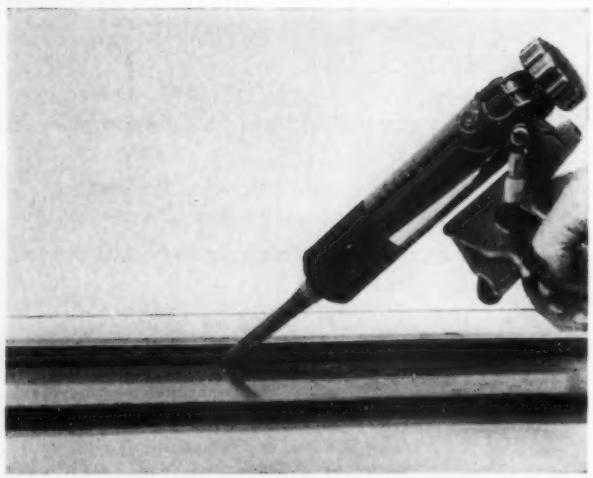
Write FOR DETAILS on Square D 2-pole devices shown. Square D Company, Dept. SA, 4041 North Richards Street, Milwaukee 12, Wisconsin

SQUARE D COMPANY

wherever electricity is distributed and controlled

Now-join aluminum with new ease

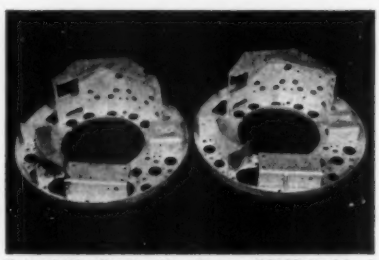




Applied with equal facility to small joints or large seams, new Alumibraze "400" is the fast, convenient way to braze aluminum parts.

If your work involves joining aluminum alloys, there's a good chance you're already familiar with the advantages of Handy Alumibraze—the salt bath brazing method that provides strong, sound, corrosion-resistant joints—with excellent reproducibility—more readily than preforms—while reducing tool and fixture costs.

Now, Handy & Harman has developed a new preparation—Alumibraze "400"—for even greater ease of application. Containing the same active ingredients as before, Alumibraze "400" is formulated to provide a homogeneous paste that can be extruded onto parts by a gun or other method.



Extrudable Handy Alumibraze "400" is ideal for brazing complex assemblies like these.

Think of the trouble this saves you. You can join extended areas and complicated contours more conveniently than ever before. Cut application and assembly times way down. Reap all the benefits of high-volume production.

Don't let another day go by without learning how Alumibraze "400" can speed operations in your shop. Our recently-expanded Bulletin 23 supplies full details. It's yours for the asking.

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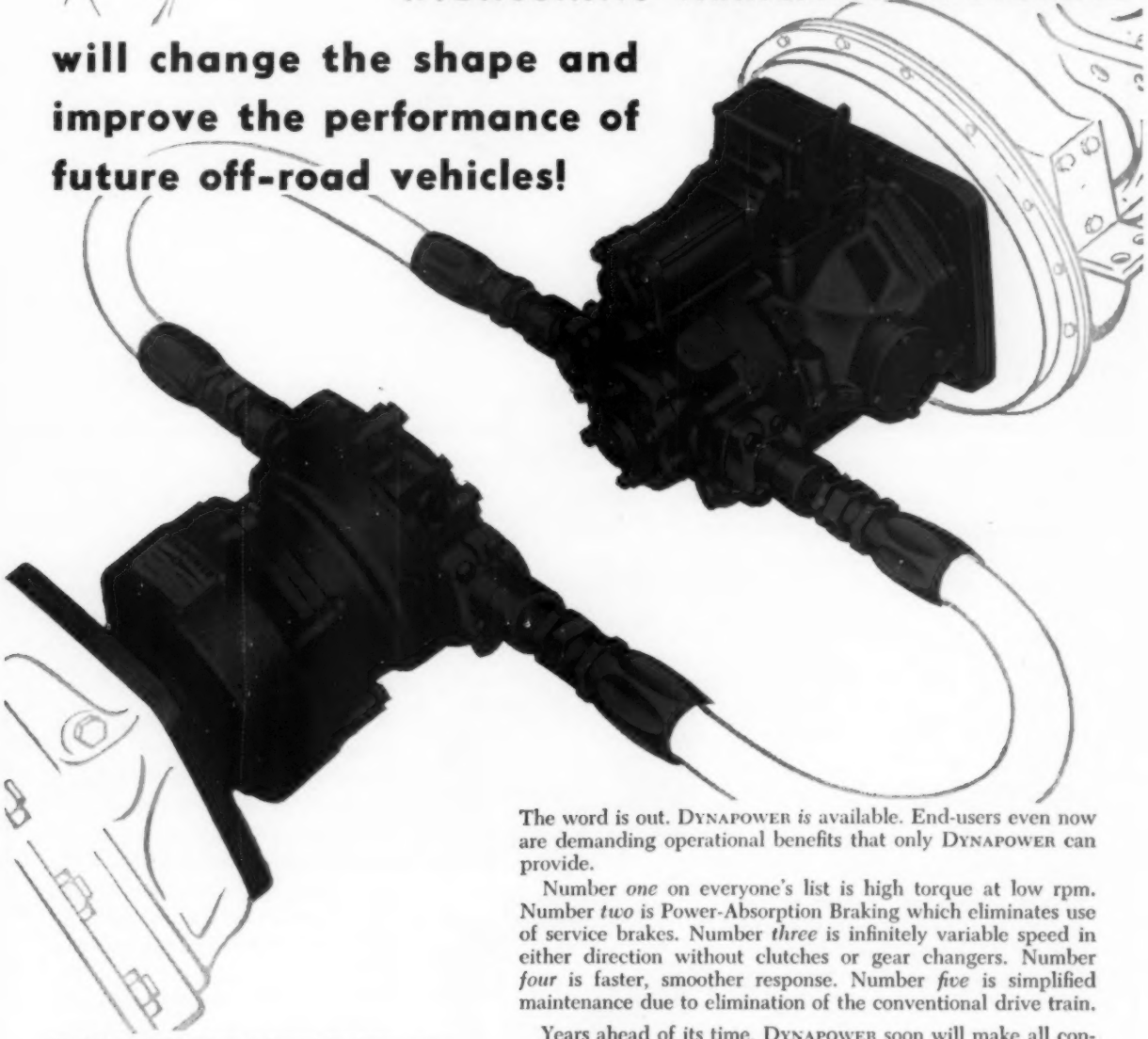
DON'T FREEZE THAT DESIGN!

Demand for DYNAPOWER® HYDROSTATIC TRANSMISSION SYSTEMS

will change the shape and improve the performance of future off-road vehicles!



This DYNAPOWER Hydrostatic Transmission System uses a separate axial piston hydraulic pump and motor to produce torque as required up to 270 lb./ft. The variable pump provides an infinitely variable speed ratio and displaces a maximum of 4.8 cu. in./rev. The transmission is rated at a normal 60 HP but handles peak requirements up to 90 HP.

The word is out. DYNAPOWER *is* available. End-users even now are demanding operational benefits that only DYNAPOWER can provide.

Number *one* on everyone's list is high torque at low rpm. Number *two* is Power-Absorption Braking which eliminates use of service brakes. Number *three* is infinitely variable speed in either direction without clutches or gear changers. Number *four* is faster, smoother response. Number *five* is simplified maintenance due to elimination of the conventional drive train.

Years ahead of its time, DYNAPOWER soon will make all conventionally equipped off-road vehicles years *behind*. Be sure you know all about DYNAPOWER before you freeze your new designs. Write today.

WATERTOWN DIVISION
THE NEW YORK AIR BRAKE COMPANY

115 STARBUCK AVENUE • WATERTOWN, N. Y.

Designed To Perform Best In YOUR Clutch Application...

CURTISS WRIGHT

CLUTCHES

Because the Marquette Division of Curtiss-Wright has a line of clutches for widely diversified uses—and a skilled staff of application engineers—you can be certain that you'll have the *best* clutch for *your* specific job.

Only Curtiss-Wright Clutches combine ALL these advantages in every size and type:

Instantaneous, positive gripping action that eliminates slippage, wear and lost time in cycling operations . . .

High speed operation with negligible centrifugal throw-out action . . .

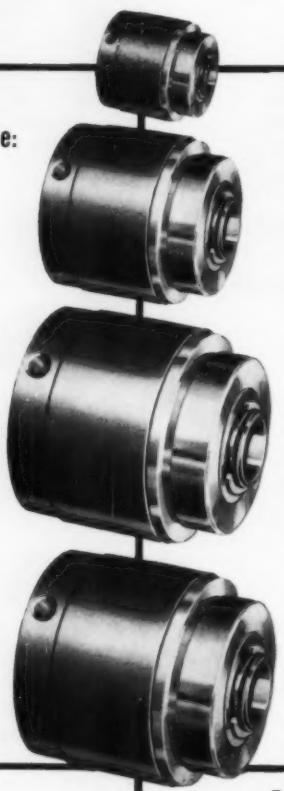
Requires only occasional lubrication and can be located in inaccessible places . . .

Smaller, lighter and more compact per inch-pound of transmitted torque . . .

Low maintenance and long life at constant torque . . .

Lower cost than other types of clutches with comparable torque rating . . .

Versatile Curtiss-Wright clutches can be used to solve many clutching or braking problems. All standard types available in torque capacities from 8 to 1250 pounds-inches.



A Curtiss-Wright Application Engineer will help you select the best clutch for your application:

OVER-RUNNING—BACKSTOPPING for transmitting power during low speed cycle; and over-running during high speed cycle; for use when a reversing motor drives two different mechanisms; to maintain one-direction shaft rotation.

INDEXING for accurate intermittent or indexing motion.

ON-OFF for selectively driving and disengaging in the same direction, where the driven member coasts.

ON-OFF INDEXING for selectively driving and disengaging in the same direction, when driven member must not coast.

INDUSTRIAL SAFETY-LOCK for bi-direction control of rotary motion.

SPECIAL PURPOSE clutches custom designed to specification.

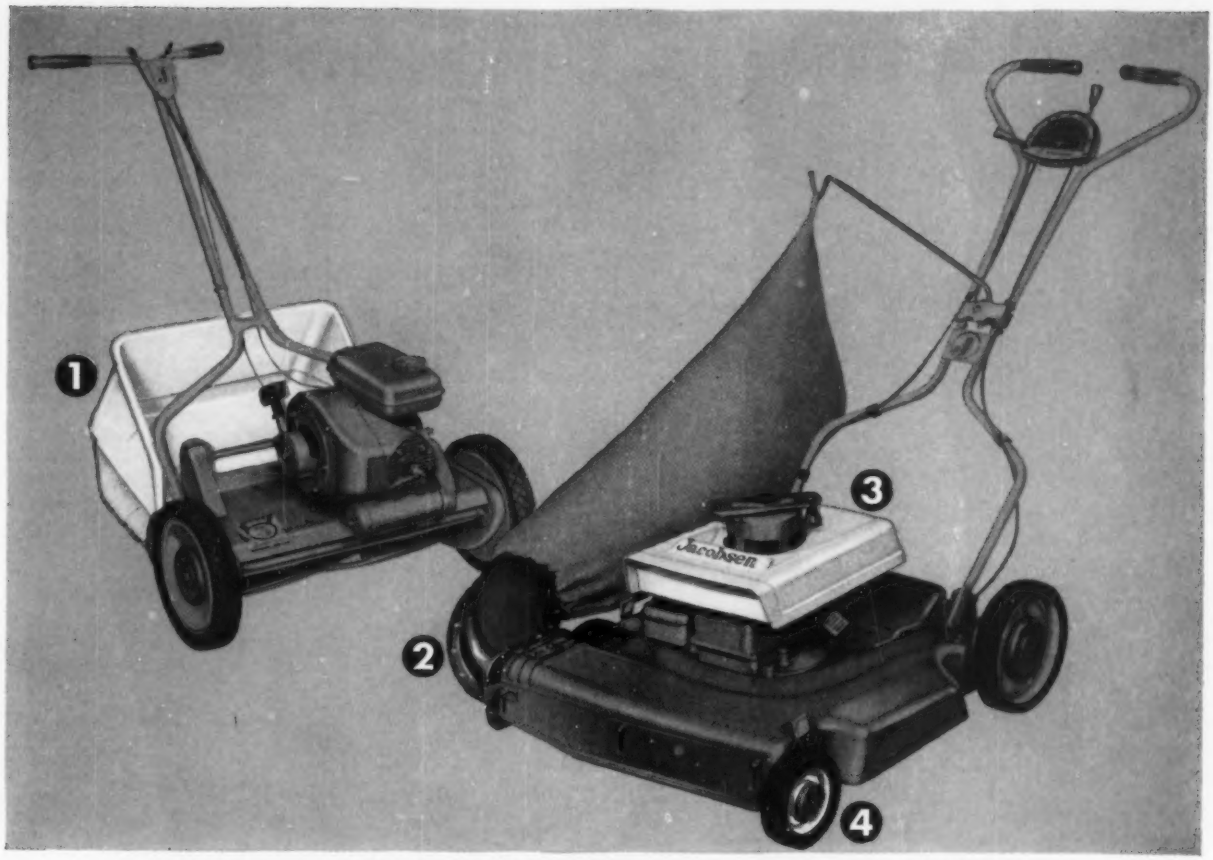
Write today for a complete catalog of Curtiss-Wright Clutches, or for consultation with a Marquette Division application engineer.

MARQUETTE DIVISION

CURTISS WRIGHT

CORPORATION

1145 Galewood Drive, Cleveland 10, Ohio



Featured above are two of the new line of high performance Jacobsen power mowers . . . and their durable, functionally styled MARLEX components—(1) grass catcher, (2) grass chute, (3) cowling, (4) wheel hub.

Tough, lightweight parts of MARLEX* increase sales appeal of Jacobsen reel and rotary mowers

Jacobsen Manufacturing Company of Racine, Wisconsin, chose parts of MARLEX high density plastic to dramatize the superior performance . . . and add increased sales appeal to their new line of high performance power mowers.

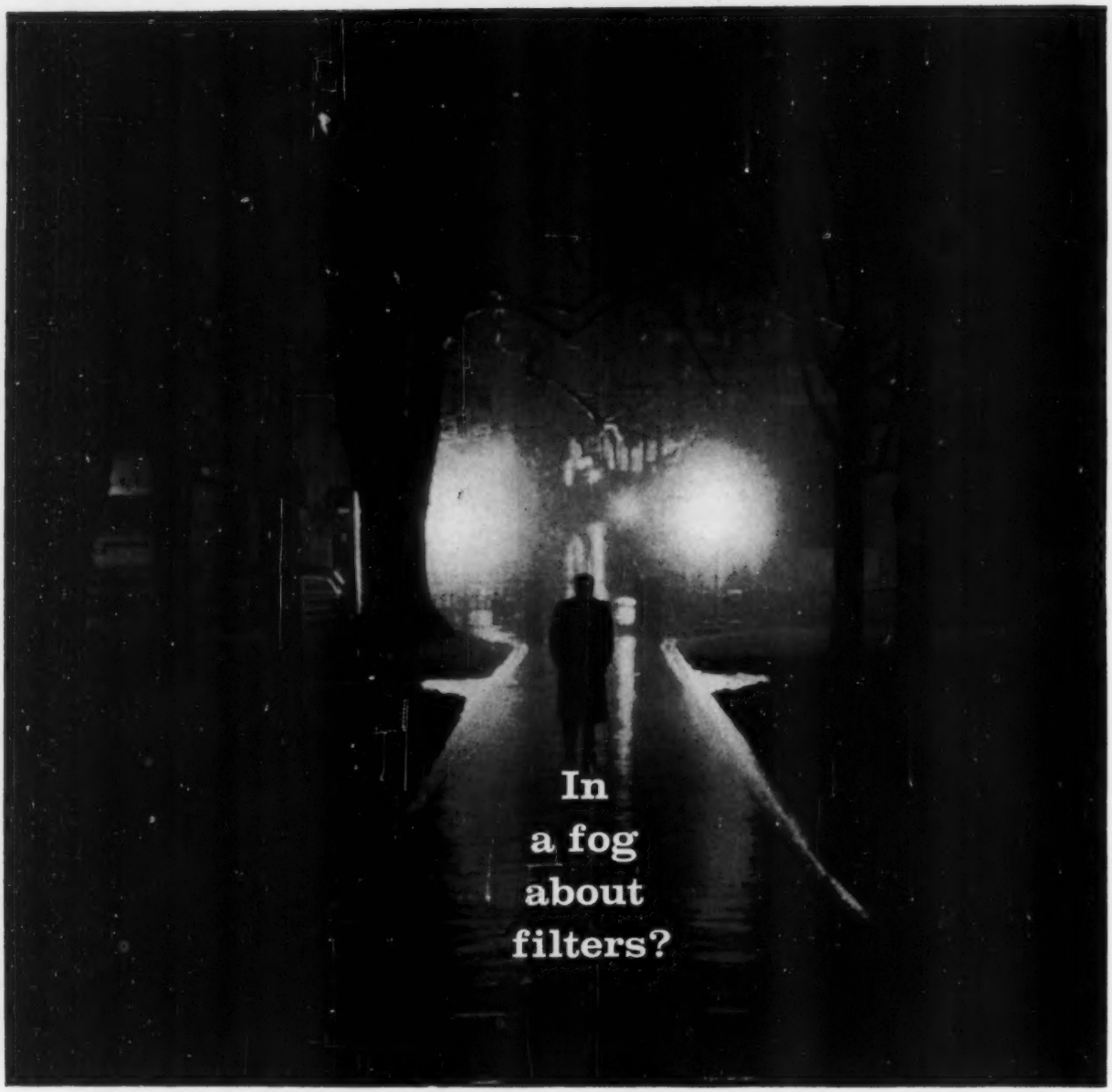
On reel mowers, grass catchers thermoformed from MARLEX sheet are lightweight, tough, and more durable. They will never rust, rot, or tear . . . should normally last the life of the mower. On Jacobsen rotary mowers, discharge chutes, wheel hubs and engine cowlings of MARLEX—functionally styled with integral color—offer the same advantages of resistance to abrasion, toughness, freedom from rust, and long life. Engine cowlings of MARLEX have the added advantage of protecting hands from accidental burning.

Jacobsen relies on MARLEX plastics (high density polyethylene and ethylene copolymers) to improve their products without increasing costs. These high quality plastics are rigid, tough, colorful, light . . . unaffected by most acids, alkalies, oils, greases, rust and rot. They also possess high di-electric strength and a wide usable temperature range (–180°F to 250°F). For more information, see your plastic fabricator or contact us directly.

*MARLEX is a trademark for Phillips family of olefin polymers

PHILLIPS CHEMICAL COMPANY
Bartlesville, Oklahoma
A subsidiary of Phillips Petroleum Company

PHILLIPS 66 MARLEX



...LET TROYFELT CLEAR THE AIR!

If you're looking for a filter material that will outperform any you've used before, you owe it to yourself to test Troyfelt.

Troyfelt is a *non-woven* synthetic felt—the fibers are mechanically interlocked. This eliminates the need for chemical or mechanical binders within the felt—those troublesome elements that are the principal cause of "blinding".

Moreover, Troyfelt is a synthetic—available in Dacron, Orlon or blends. As such, it offers users outstanding abrasion, heat and chemical resistance properties.

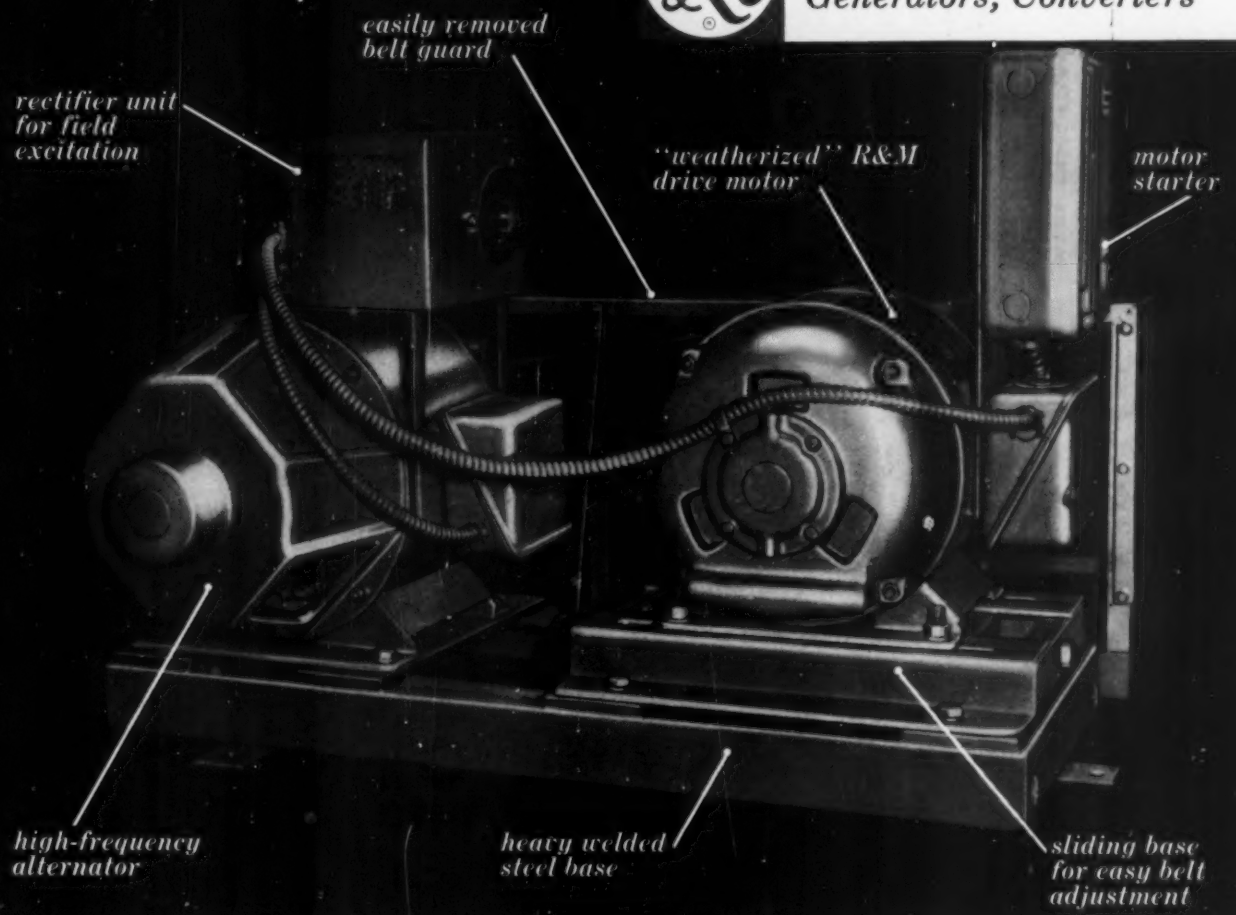
But most important: we can match *your* needs precisely. We can give exactly the weight, density, thickness, permeability and strength you want. Tell us your problem and we'll "Tailor" Troyfelt to do the job. Meanwhile, send for samples and our latest brochure.

TROYFELT—MATERIAL OF A HUNDRED AND ONE USES
• vibration dampening • gasketing • seals • polishing
• insulating . . . wherever felt's a factor, test Troyfelt

TROYFELT... by the pioneers in non-woven synthetic felts
INDUSTRIAL PRODUCTS DIVISION • TROY MILLS, INC.
200 MADISON AVENUE • NEW YORK 16, NEW YORK

high frequency

Generators, Converters



Compact High Frequency Power Generators

360 to 3300 cycles

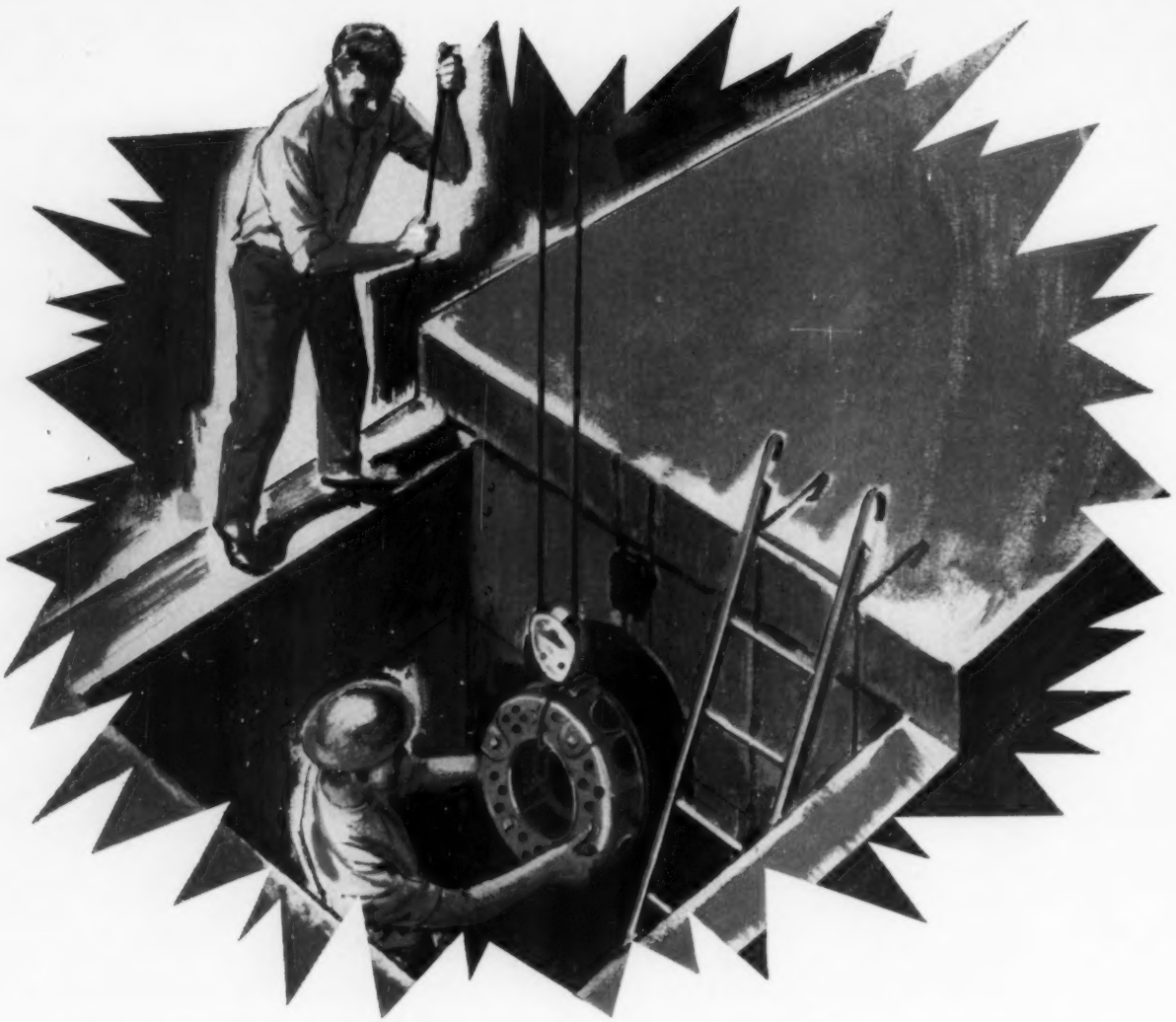
R&M package high cycle generators provide dependable current beyond the practical range of frequency converters. Rugged revolving field construction is used in ratings of 1500 cycles and lower. Ratings above 1500 cycles are brushless inductor design. Excitation of DC alternator field is provided by simple silicon rectifiers, protected against short circuits by time-delay fuses. For changing output frequency, R&M can furnish variable pitch pulleys or variable speed drives. R&M's low-cost frequency converters make 220 volt-3 phase-120 through 420 cycle power available from 60 cycle supply . . . rated 2½KW (horizontal construction) 5, 7½ and 10KW (vertical).

Write today for bulletin 515A-PRE!

ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors • Electric Hoists and Overhead Traveling Cranes • Moyno® Industrial Pumps
Propellair® Industrial Fans • R & M-Hunter Fans and Electric Heat • Trade-Wind Range Hoods and Ventilators
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.

CIRCLE 45 ON READER SERVICE CARD



TORTURE-TEST PITS burst clutches to bits

Rockford Clutch reliability is due to the varied and frequent quality checks made at every production step. At specified intervals, clutches are removed from the production line and lowered into torture-test pits. Severe centrifugal tests spin these clutches to destruction! Each tested clutch, however, must withstand predetermined ultra-high speeds for specified time limits . . . another quality control check made to assure you of Rockford Clutch dependability. Rockford offers you an extremely wide range of proven power controls. Write today for illustrated brochure.

. . . assures you safe, enduring clutch performance!

ROCKFORD CLUTCH
209 CATHERINE STREET, ROCKFORD, ILLINOIS
Export Sales Borg-Warner International • 36 So. Wabash, Chicago, Ill.

ROCKFORD B-W CLUTCH DIVISION OF BORG-WARNER

LET MUELLER MAKE IT!

Mueller Brass Co. of Port Huron is much more diversified than the name "Brass" implies . . . a lot more. In fact, because of its many and varied facilities . . . its *men, methods* and *metals* . . . Mueller is in the unique position of being able to offer true single source service.

MUELLER HAS THE MEN . . . experienced engineers with the ability to work out, creatively, tough design problems, and improve a part or components for production by the most economical method. You get sound engineering plus 44 years of practical metalworking production experience when you "Let Mueller Make It".

MUELLER HAS THE METHODS . . . when you "Let Mueller Make It", you are utilizing one single source that is able to produce parts any one of these ways: as forgings, impact extrusions, sintered metal parts, screw machine products, formed tube or as castings.

MUELLER HAS THE METALS . . . and the materials . . . to produce precision parts in aluminum, brass, bronze, copper, iron and steel in hundreds of different alloys to meet each exact requirement.

In addition, Mueller Brass Co. has complete and modern facilities for performing all types of finishing and sub-assembly operations. Another plus value is nation-wide sales engineering service.

So, in the final analysis, no matter where you fit in the American industrial picture, whether you're making missiles or mowers . . . and no matter where you're located, it will pay you to LET MUELLER MAKE IT!

MUELLER BRASS CO. PORT HURON 29, MICHIGAN

See Us At Booth 701—Design Engineering Show—Cobo Hall, Detroit, May 22-25

340

YOU CAN ADD THIS ENGINEERING TEAM TO YOUR STAFF WHEN YOU

LET MUELLER MAKE IT!

When you work with the Mueller organization, a qualified team of trained, experienced and imaginative engineers automatically become part of your staff and go to work for you. This engineering team, which includes specialists in all categories of design work and production procedures, carefully considers all aspects of your particular part or assembly and its function. In conjunction with members of your engineering department, Mueller engineers can help design or re-design your part for improved performance, eliminate, where possible, unnecessary parts through re-design by making two or three part assemblies as a single piece, and recommend the best method of production. Mueller people also consider ways of speeding your finishing and assembly operations. Production economies consistent with product quality are always a prime consideration.

This TOTAL CONCEPT engineering service, which costs no more, is available to you when you . . . LET MUELLER MAKE IT!

MUELLER BRASS CO. PORT HURON 29, MICHIGAN

See Us At Booth 701—Design Engineering Show—Cobo Hall, Detroit, May 22-25

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CIRCLE 48 ON READER SERVICE CARD

Here's 0.1° Sensitivity at a Competitive Price!

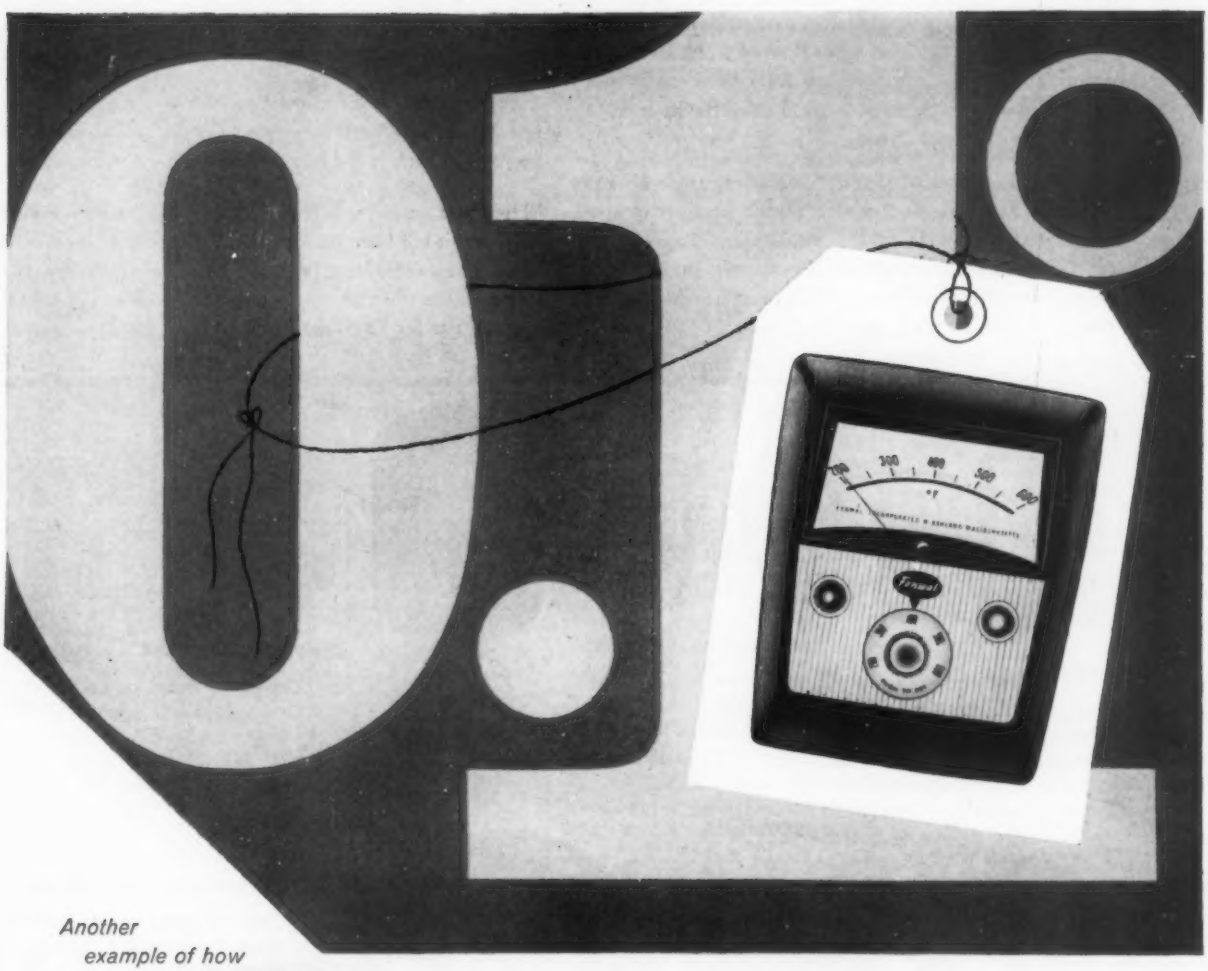
... Fenwal's New "561" Temperature Controller

The new "561" indicating controller responds to temperature changes of 0.1° or less! And is yours at a competitive price! These two features alone make it an instrument you should investigate... but there's more!

You can choose from five standard temperature ranges . . . within the span of −50 to 600°F. Furthermore, scales start and end within *your* ranges, permitting larger graduations, better legibility, easier readout. And control and indication are separate but simultaneous. *Should your indication fail the "561" will continue to control with complete accuracy.*

This precise instrument gives unvarying performance. Its indication and control will not vary with fluctuations of input voltage nor changes in ambient temperature. It offers the option of either ON-OFF or proportional control . . . has 10 AMP/120 VAC relay capacity. Smartly styled to complement modern industrial machines and interiors, *the "561" offers you all these extras at a competitive price.*

A Fenwal engineer will be glad to supply information on the "561", or any other temperature control in Fenwal's broad line. Write Fenwal Incorporated, 25 Pleasant Street, Ashland, Massachusetts.



Another example of how

Fenwal CONTROLS TEMPERATURE . . . PRECISELY

TO INSURE SUCCESSFUL PERFORMANCE

EVERY GRAMIX® PART IS

(PRODUCTS OF POWDER METALLURGY)

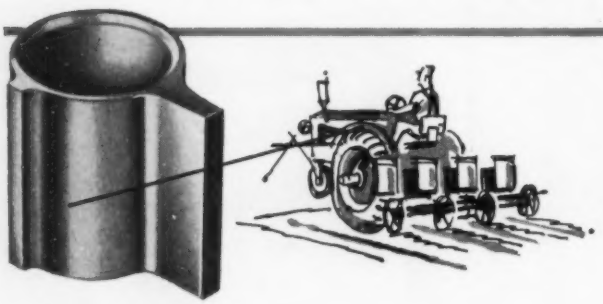
APPLICATION ENGINEERED

One of the most important factors to consider when purchasing powder metal parts is that of successful part performance; for a part to successfully perform its job, all of its physical and metallurgical characteristics must be suited to the application.

GRAMIX Products of Powder Metallurgy are always *Application Engineered,* which means product is specially matched to each specific application. From an almost unlimited variety of metal mixtures, one alloy is blended that contains the required properties and characteristics of the finished part; *all* aspects of part design and conditions under which it must operate are taken into account. Only then is the GRAMIX part produced.

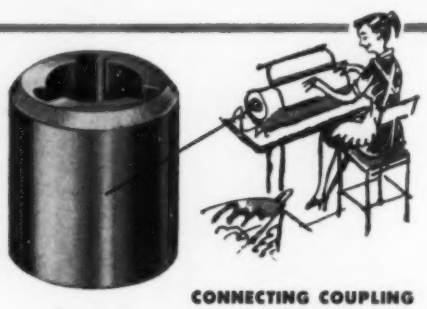
Eight of these *Application Engineered* GRAMIX parts are shown here. Each precisely suits the requirements of its job . . . each is the best part available for the job.

When you specify a GRAMIX part, you can always be sure that it has been *Application Engineered* for successful performance, long life and complete reliability. For more information on *Application Engineered* GRAMIX parts, write for Engineering Handbook G-55.



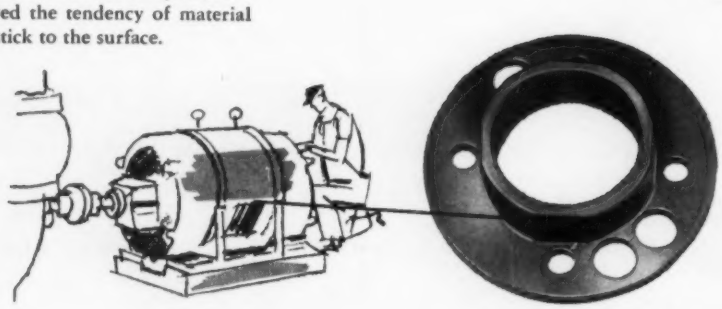
CORN SEEDER

GRAMIX was the material specified for this corn seeder part because the surface finish obtainable with the alloy used reduced the tendency of material to stick to the surface.



CONNECTING COUPLING

The connecting coupling employed in a small home ironer is formed from a special GRAMIX hardened steel alloy; it offers low wear and shock resistance.



CONTAINER COVER END CAP

Great savings were realized when retainer caps for certain types of electric motors were made of GRAMIX.

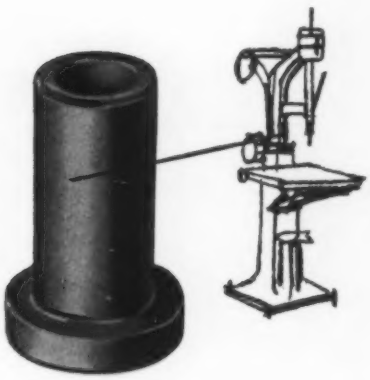
This process made it simple and economical to mold the multiple holes to precise tolerances without extra operations.

HELICOPTER THRUST WASHER

The outstanding features of the GRAMIX alloy specified for this thrust washer are a dependable and consistent friction and wear pattern as well as a fine surface finish.

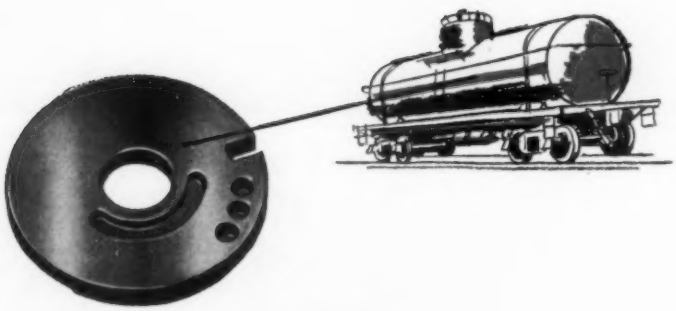
TAPE RECORDER SPINDLE

One of the important requisites in a tape recorder is a low noise level. United States Graphite Company engineers developed a special alloy to meet these requirements in the GRAMIX spindle.



GUIDE BEARING

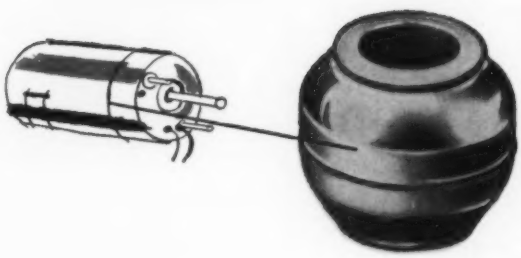
Built-in lubrication and low friction to reduce heat are important features of the GRAMIX alloy chosen for this guide bearing.



LIQUID PUMP END PLATE

This end plate is typical of many parts employed in liquid pumps of many types.

It is made from a wear resistant bronze alloy that was developed for pump applications.



FRACTIONAL H.P. MOTOR

The GRAMIX bearing for this Fractional h.p. motor was developed from a special low noise level alloy.

Its self-lubricating properties were also an important consideration in specifying GRAMIX.

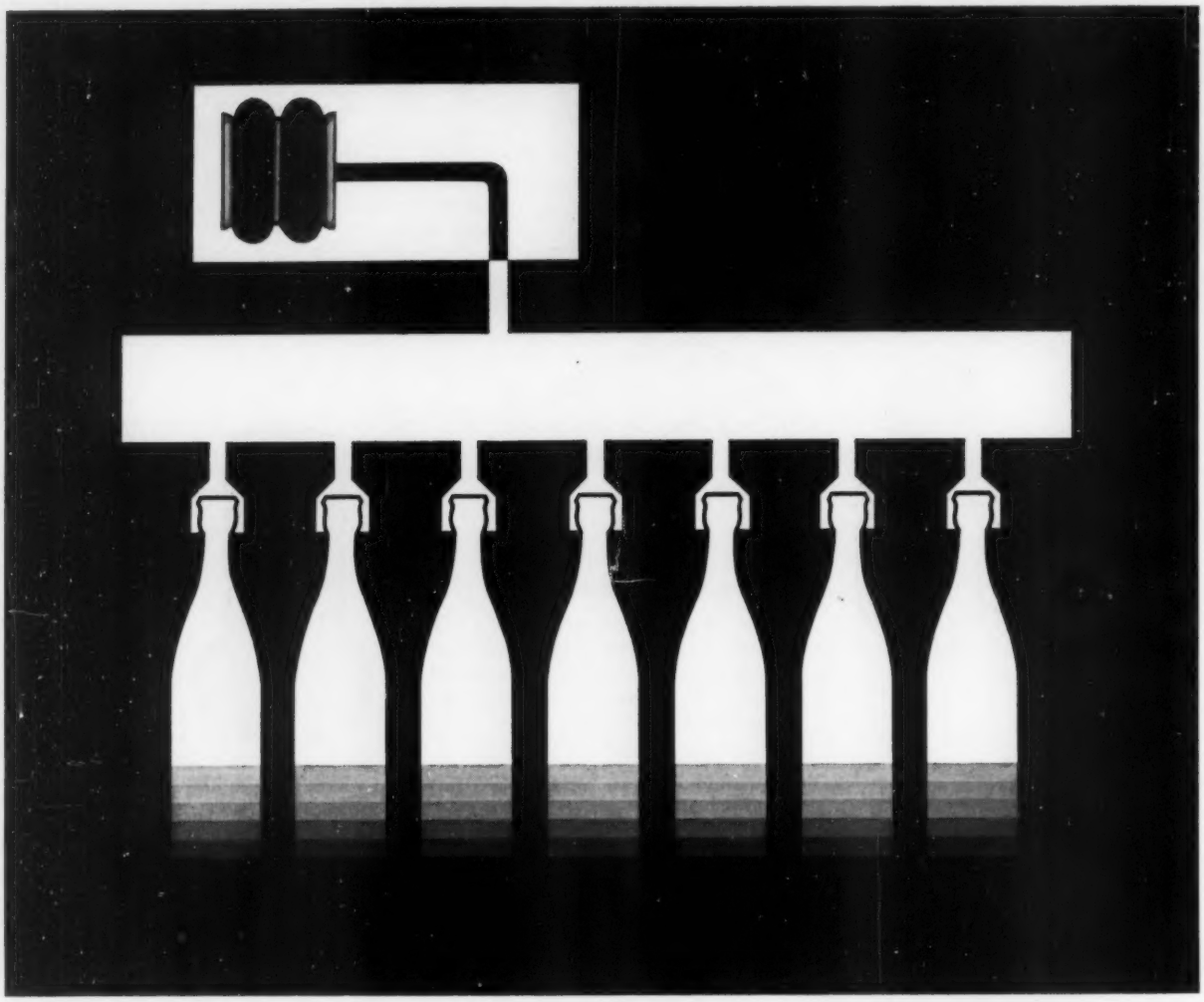
METAL POWDER mpi INDUSTRIES FEDERATION

X-296-2

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 1, MICHIGAN

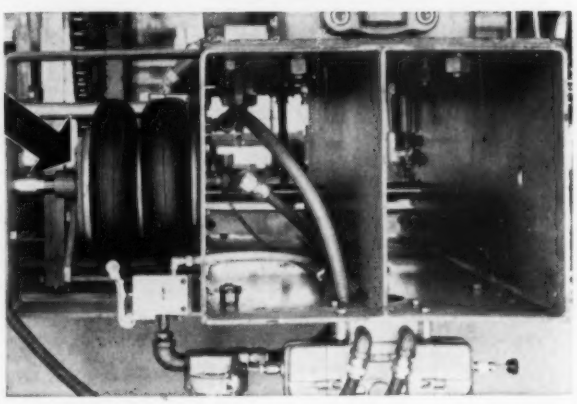
GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



How to cut "breathing" costs for a bottle lifter

Firestone Airmount® replaces three metal pumps, costs less, lasts longer, cuts maintenance

Until recently, chambered metal pumps created the differential pressures required to set the grip of rubber pick-up cups used in Lodge and Shipley pneumatic bottle lifters. Then their engineers replaced the complex pumps with low-cost Firestone Airmounts—creative thinking that paid off: Firestone Airmounts require virtually no maintenance, last much longer and initial cost is substantially less. And, in some applications, one Airmount did the work of *three* of the expensive pumps. This is only one of many ways Firestone Airmounts meet industry problems with low-cost, long-term solutions. Write Dept. 41-2 today, without obligation, for details on how they can serve *you*.



Firestone Airmount is stroked to pump air into inflatable pick-up cups to grip and lift bottles. Simplified design saves Lodge and Shipley money, allows more compact system designs, too.

Firestone

INDUSTRIAL PRODUCTS COMPANY

Noblesville, Indiana • AIRMOUNT® FOR INDUSTRY

Wider Range of Gas Heat Control

now available from Robertshaw

Equipment designers now have a wider temperature range . . . from 150° to 700°F . . . in which to design and operate gas-fired equipment and appliances . . . with full control at any point in the temperature range.

The perfection of a combination snap and throttle thermostat, Robertshaw's **FLAME MASTER FD** gives flat-line control from 300° up . . . and very modest fluctuations in the low range, with full control down to 150°. Even the *minimum* flame setting is under thermostatic control.

With Robertshaw's **FLAME MASTER FD** also comes wide adaptability of installation through design flexibility to meet your product's physical requirements.

Robertshaw engineers will be glad to review the temperature control requirements of your new product design in the strictest confidence.

FLAME MASTER FD could well be the temperature control you need. Write Robertshaw Thermostat Division, Robertshaw-Fulton Controls Company, Youngwood, Pennsylvania. For real fast service, use DIRECT DISTANCE DIALING. Dial 412-242-7171.

Robertshaw

. . . the name that MEANS temperature control

VHA 6023

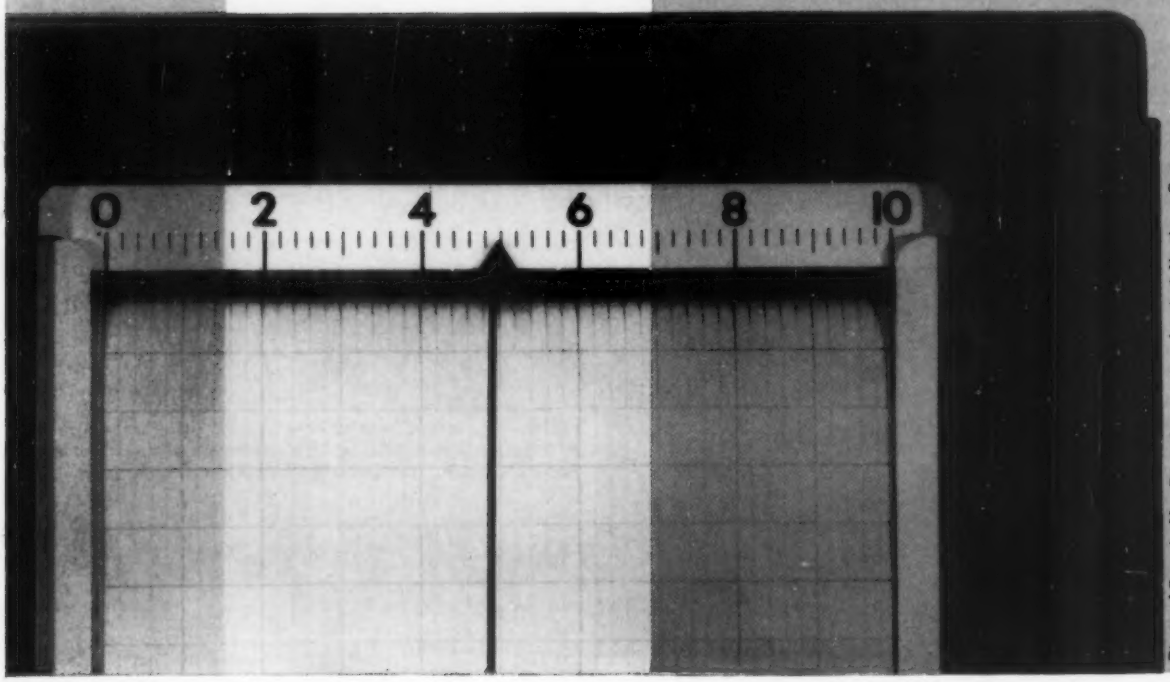


Photo of Speedo-Max Recorder courtesy Leeds & Northrup Company

Designers think of R/M first for asbestos, rubber,

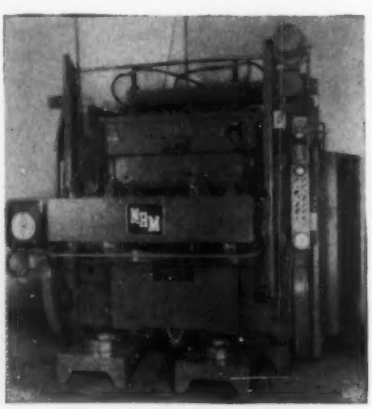
Solves major operating problems for tire press manufacturer with new Teflon*-impregnated molded asbestos piston cups

New molded asbestos piston cups impregnated with Teflon, developed by Raybestos-Manhattan, Inc., have enabled National Rubber Machinery Company, Akron, Ohio, to improve the economy and efficiency of its Autoform Slideback Tire Press while realizing substantial savings. The new seal has not only reduced air loss to a minimum, but eliminated a lubrication system, cut maintenance, and increased machine operating life.

Before adopting R/M cups, NRM used metal rings for the ram and cylinder assembly. These did not provide the seal required, permitted a 5 to 10% air loss, caused excessive wear on moving parts, and required lubricants which were entrained, seeped into the molds, and damaged the tire rubber.

In considering a suitable replacement for the metal rings, NRM tested various synthetic rubber and leather cups. All deteriorated rapidly in temperatures up to 380°F. Then R/M was consulted. Preliminary investigation indicated asbestos with a Teflon filler as a potentially good combination for this application. Nearly a year of research, testing and engineering collaboration followed. Samples were developed and tested in the field under actual operating conditions. Only when all results were in—after two years—did NRM adopt R/M cups for use in all its presses.

R/M's experience in the manufacture of packings, gasket materials, and specialty products to meet the exacting and varied requirements of industry is at your disposal—whatever your need call on R/M.



The application of R/M piston cups provided two important benefits. It eliminated oil in the curing room, preventing damage to the tire rubber. It reduced air loss with properly fitted and installed cups.

Registered trademark for Du Pont fluorocarbon resins

PACKINGS

For complete information on R/M Molded Piston Cups and other R/M packings and gasket materials, write for new Catalog P-100. Packing Division, Raybestos-Manhattan, Inc., Passaic, N.J.

sintered metal, and engineered plastic products

Non-burst Rubber Steam Hose

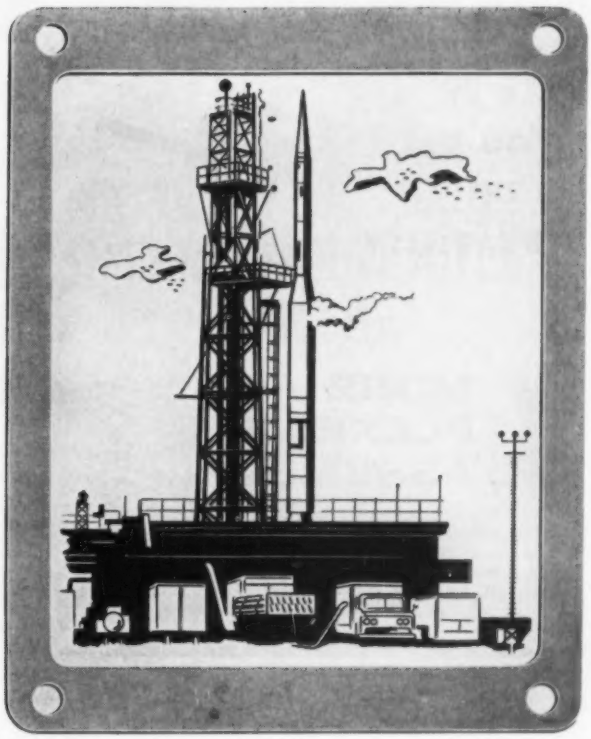
Strength of steel, heat resistance of asbestos, flexibility of rubber

For saturated steam pressures to 200 lbs., 388°F. Strength and durability are employed throughout the construction of Super-Master BW Steam Hose, illustrated above. Braids of high-tensile, non-corrosive steel wire are applied at a controlled angle over an asbestos-covered steam-resistant rubber tube for greatest strength with minimum elongation and contraction, and provide positive protection against bursting. Special Butyl rubber cover resists heat and weather, has static dissipating wire. The safest high-pressure steam hose made. Write for Bulletin M630.

Rubber hose for every purpose—air, oil, suction, Teflon hose for corrosive chemicals, flexible rubber pipe and expansion joints for abrasion and vibration . . . outlasts steel pipe. Write for Catalog M5.

RUBBER

Write today for free booklet shown: full details on a wide variety of industrial rubber products. Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J.



Most advanced gasket material yet for missile fuel systems

R/M FLUOROBESTOS*—an asbestos felt impregnated with "Teflon," is fast becoming the accepted gasket material for missile fuel systems.

Approved by leading missile manufacturers for its compatibility with LOX and other exotic fuels, this new material combines "Teflon" and Pyrotex,® a carded asbestos felt based on extra-long spinning grade fiber.

In airborne and ground support applications, gaskets of Fluorobestos offer weight savings, high resistance to acids and solvents, and less deformation under load (as little as 0.1% under pressures of 2000 psi at temperatures to 500°F).

Fluorobestos is available in standard sheets of 40 x 40 in., in thicknesses from .015 to .125 in. Write for complete information and test samples.

**Registered trademark for R/M reinforced asbestos Teflon sheet.*

PLASTICS

For a copy of this booklet, full of information on R/M's complete line of "Teflon" Products, write Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Paramount, Calif. • No. Charleston, S.C.
Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

WHEN YOUR "SPECS" READ HYATT YOU GET TRIPLE VERSATILITY

USE THE HYATT IMPROVED

1 MORE FLEXIBLE ASSEMBLY

Interchangeability of Hyatt separable bearing parts permits more flexible assembly. Any HYATT Metric Radial Series separable inner race, for a given piece number, can be assembled with any HYATT outer race and roller assembly of the same piece number.

Because of this interchangeability, it is practical to install separable HYATT inner races on shafts in one location, while the outer races and rollers are installed in housings at another location. When the sub-assemblies are brought together, the bearing parts will match perfectly. There is seldom need for selective assembly.

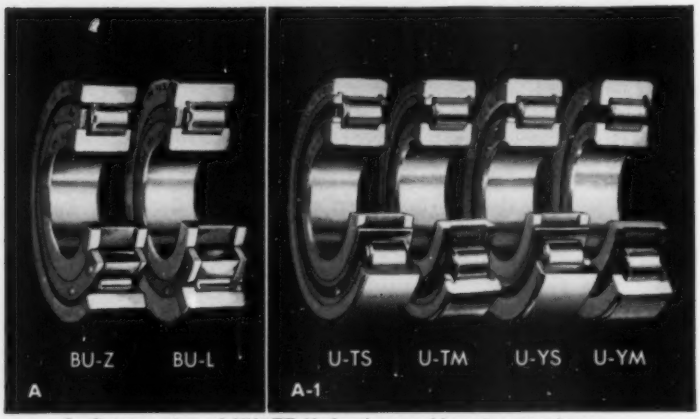
2 INCREASED SHAFT DIAMETERS

When the designer wishes to use a larger, more rigid shaft, without increasing the size of the housing bore, he utilizes another advantage of HYATT separable bearings. He can eliminate the inner race of the separable inner race HYATT bearing types and operate the bearing rollers directly on the suitably hardened and ground shaft. Space usually occupied by the inner race is available for a larger shaft.

3 REDUCED HOUSING BORE SIZES

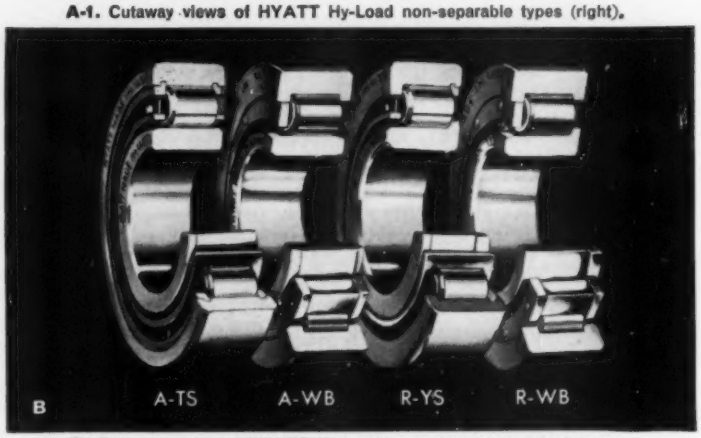
On the other hand, when space limitations force you to reduce the size of the housing bore without decreasing shaft diameter, versatile HYATT separable bearings are again the answer. This time you merely eliminate the outer race of one of the separable outer race HYATT bearing types—and operate the rollers directly on the suitably hardened and ground bore. You save the space normally occupied by the outer race.

And, of course, in applications where it is advisable to retain the complete bearing parts as a unit, HYATTS are available in non-separable assemblies.



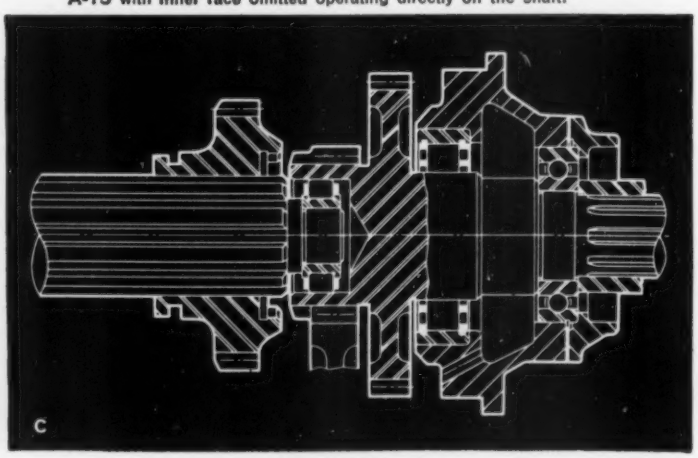
A. Cutaway view of HYATT Hy-Load separable outer race types.

A-1. Cutaway views of HYATT Hy-Load non-separable types (right).



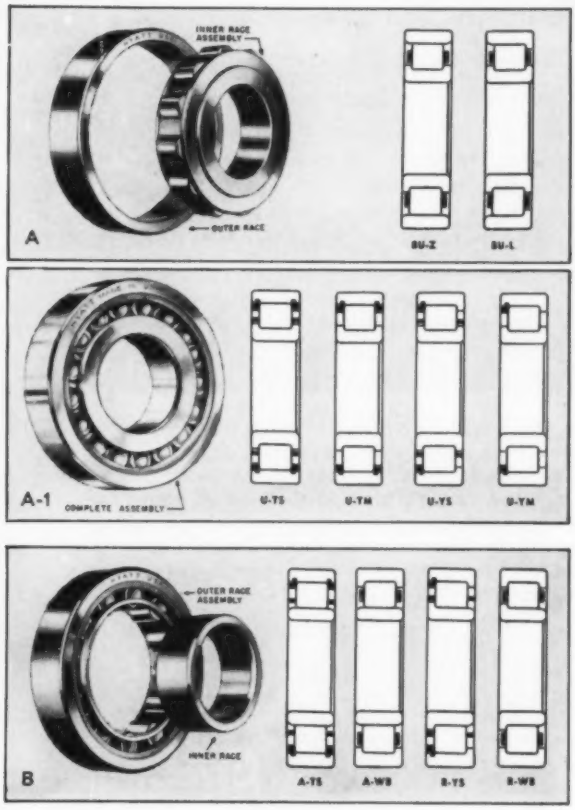
B. Cutaway views of HYATT Hy-Load separable inner race types.

C. Typical transmission application: Pilot bearing is BU-Z type without outer race, operating directly on hardened and ground gear bore, and an A-TS with inner race omitted operating directly on the shaft.



LINE FOR MACHINE DESIGN

SEPARABLE RACE ROLLER BEARINGS *with* INTERCHANGEABLE PARTS



Design engineers have come to recognize—and deal with—one stubborn fact in their business.

The stubborn fact: *Every bearing application has its own peculiarities.*

The way to deal with it: *Use the HYATT LINE!*

The core of the Hyatt Plan is simply this. Hyatt's separable race roller bearings—with interchangeable parts—permit you to improve machine design. They encourage improved machine design because they are adaptable to highly individual and unique applications.

Naturally, HYATT cylindrical bearings have more radial load-carrying capacity. Their true rolling action offers the lowest roller bearing friction. But the shrewd engineer looks beyond these basic life, load and speed relationships. He studies the installation, sealing, retainment, assembly and maintenance requirements of each individual bearing application.

In short, he uses the HYATT LINE for best results.

Pick up the phone the next time you want to review your bearing applications—for an overall production or performance advantage for your product. Call your nearest HYATT sales office.

You'll find the best roller bearing engineers anywhere at the other end of the line.

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FOR MODERN INDUSTRY

IN ROLLER BEARINGS, HYATT IS THE WORD FOR GM GENERAL MOTORS RELIABILITY

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

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No doubt about it—it's important to keep correspondence carefully filed; *but* it is even more important to equip your drafting department with modern filing facilities that keep active and semi-active drawings readily accessible, fully protected—and in a minimum of space.

Your draftsmen, your productivity, deserve new Hamilton space-and-time-saving equipment—from Ridgway's

Inadequate or antiquated equipment in your drafting room *can cost you more money* than you imagine in lost time, errors, done-over work, and low morale. Hamilton equipment is *engineered* to fit your needs. It is *designed* to improve the practical, day-to-day creativity of your engineers or draftsmen. Its performance has been tested and *proved* in many thousands of installations. Our designers will gladly assist in the planning of your department. No obligation, of course.

HAMILTON UNIT SYSTEM FILES The Hamilton system offers maximum protection and capacity in minimum floor space. Each drawer of the patented shallow drawer units is equipped with a tracing lifting mechanism. Every tracing becomes a top sheet, instantly accessible. Unit sections can be assembled in a number of arrangements, stacked safely to any practical height. They stand up to hard usage, perform perfectly year after year.

Hamilton L-Contour Table
Prestige-assured, individualized work area providing complete board adjustment plus extra storage and reference area.

Hamilton CL 100 Drafting Table
Conserves dollars, yet rugged canted-leg design provides modern styling and convenience with long-term durability.

Hamilton Auto-Shift Table
Built-in mechanism adjusts board to individual height and slope requirements, provides full accessibility, reduces errors.

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augmenting the industry's broadest line

With the addition of the 50-Amp Silicon Controlled Rectifier, Transitron now offers the industry the broadest line of Controlled Rectifiers available on the market today.

Research and development efforts during the past year have already produced an impressive array of types which include the following series:

TSW31S SERIES (TO-18 package).....operating current range to 200mA
TCR251 SERIES (TO-5 package).....operating current range to 1 amp
2N1595 SERIES (TO-5 package).....operating current range to 1 amp
2N1600 SERIES (7/16" hex package)...operating current range to 3 amps
TCR505 SERIES (7/16" hex package)...operating current range to 5 amps
TCR510 SERIES (11/16" hex package) operating current range to 10 amps
TCR520 SERIES (11/16" hex package) operating current range to 20 amps

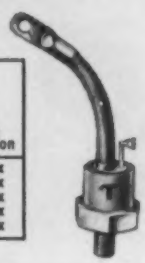
NOW AVAILABLE — NEW 50-AMP CONTROLLED RECTIFIER

The latest addition to the Transitron line — the 50 Amp Silicon Controlled Rectifier — is a three-terminal, four-layer device designed to control very large load currents with small gate current signals. A mechanically rugged and electrically stable device, the new Controlled Rectifier is provided in the 1 1/16" hex base stud-mounted package and is hermetically sealed. Wherever high power handling ability is required, the 50-Amp Silicon Controlled Rectifier will find wide application ranging from frequency changing to welding control.

TCR550 SERIES (1 1/16" hex package) operating current range to 50 amps

Type	Min. Peak Reverse Volt. and Min. Forward Breakover Volt. (volts)	Max. Average Forward Current at 90°C case (amps)	Package Configuration
TCR4050	400	50	1 1/16" hex
TCR3050	300	50	1 1/16" hex
TCR2050	200	50	1 1/16" hex
TCR1050	100	50	1 1/16" hex
TCR550	50	50	1 1/16" hex

Requires 50mA to turn on 50 Amp



For information on any or all of Transitron's line of Controlled Rectifiers, call or write today for Bulletin TE-1356.

WHY BIAS CONTROLLED RECTIFIERS?

Pioneering in *new* application techniques, Transitron application engineers have assembled information which demonstrates how "gate biasing" will improve the circuit reliability of the SCR. This informative booklet, entitled "The Biasing of Silicon Controlled Rectifiers and Switches," deals individually with *each* of Transitron's Controlled Rectifiers and Switches. It is an indispensable aid to the design engineer seeking *longer life* and *greater stability* in higher temperature applications . . . It's yours for the asking.

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The cylinder simplifies your design work substantially, because it produces virtually any kind of motion—and does so *without the use of complex mechanical contrivances!*

It provides constant, even pressure at all times, and this pressure can be varied with a simple adjustment. Its compact size, along with the use of a flexible line, makes it easily adaptable to special machine design.

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United-Carr's engineering staff offers you a wealth of experience in the design of special-purpose fasteners and self-fastening devices. Large-scale manufacturing facilities (including in-plant plastics molding equipment) ensure economical, *volume* production and prompt deliveries. United-Carr field representatives are ready to call on you at *your* request.

POLYETHYLENE MOUNTING FOOT

No mar, no scratch glide for use on TV receivers, record changers, small appliances, etc. Assembles into round hole in wood or metal cabinets.

The names DOT, TEENUTS, TRIMOUNT are registered trade-marks of United-Carr Fastener Corporation

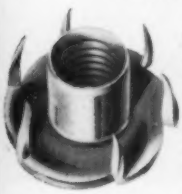
NYLON SNAP-IN NUT

Snaps into square hole stamped out of sheet metal . . . provides secure anchorage for any sheet metal or self-tapping screw . . . highly effective electrical insulator.

QUICKEY FASTENER

Eliminates need for welding or swaging studs to sheet metal stampings, facilitates nesting, eliminates damage in transit because Quickey snaps in before final assembly.

6-PRONG TEENUT

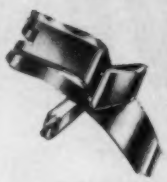


Offers greatly increased push-out resistance; virtually eliminates the problem of lost fasteners, cuts rejections, customer complaints, etc. Claw-like prongs toe in for maximum gripping power.

PLUG BUTTONS

Snap into ⅛" to 3" dia. holes. Can be embossed with ornamental or functional designs . . . various finishes, shapes and sizes.

WIRING FASTENER

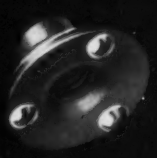


Mounting legs snap into round hole . . . provide secure anchorage. Body of fastener holds wires without chafing.

MOLDING FASTENER

Ideal for use with thread cutting fasteners or available with threaded stud for nut and lock washer assembly. Spring leg maintains tension to keep fastener blade locked in molding channels.

TEENUT



One-piece, all-metal nut has welding bosses on upper or lower surface of mounting flange. Has high tensile strength and provides secure, permanent anchorage for bolt. Available in various shapes and sizes.

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Hold two or more thicknesses of material together. Easily installed by hand. Insure vibration proof attachment. Permanent or removable. Many shapes and sizes.

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Snap fastener for cloth, leather, plastics and other materials. Positive closure, instant release. Black, nickel or brass finish.

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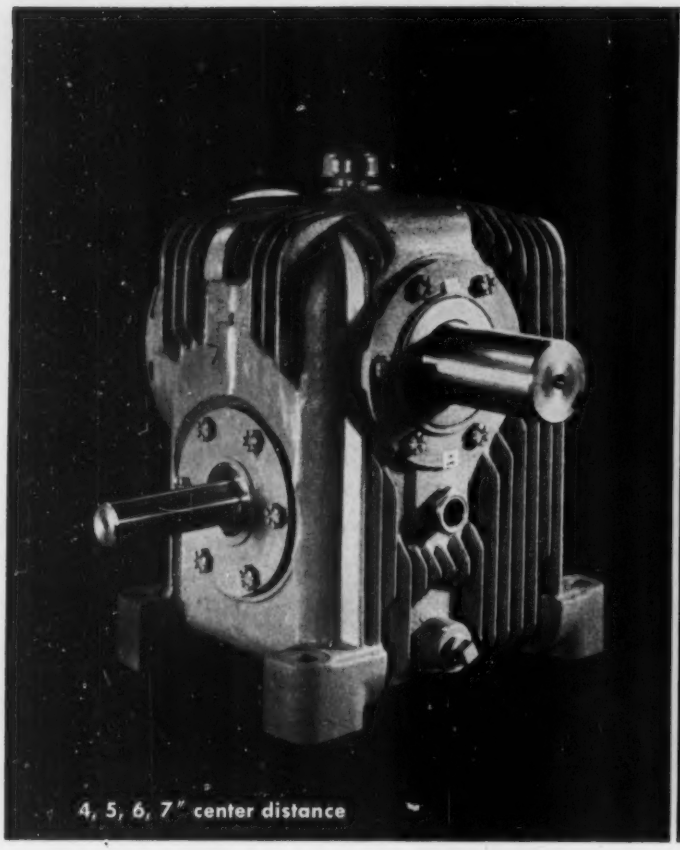
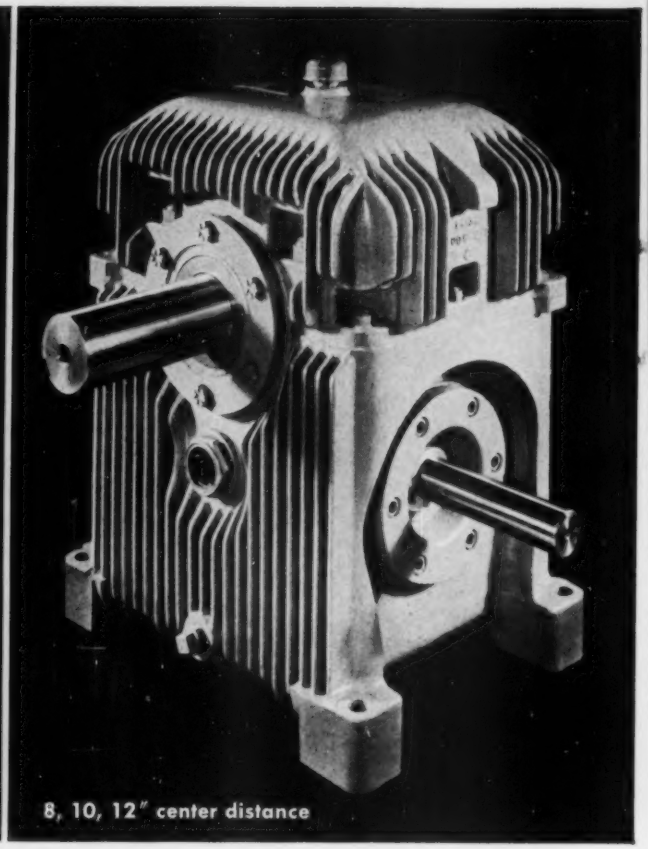


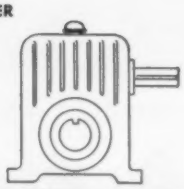
4, 5, 6, 7″ center distance



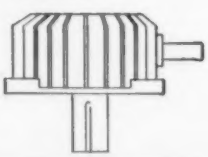
8, 10, 12″ center distance

CONE-DRIVE REDUCERS

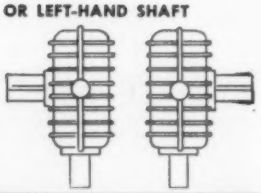
WORM-OVER



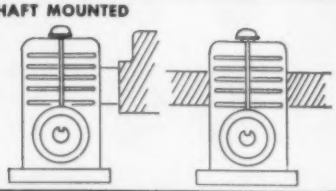
VERTICAL GEARSHAFT



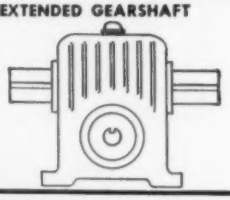
RIGHT- OR LEFT-HAND SHAFT



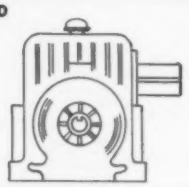
SHAFT MOUNTED



DOUBLE-EXTENDED GEARSHAFT

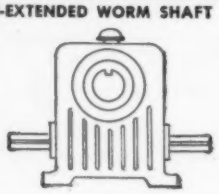


FAN-COOLED

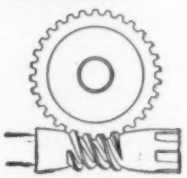


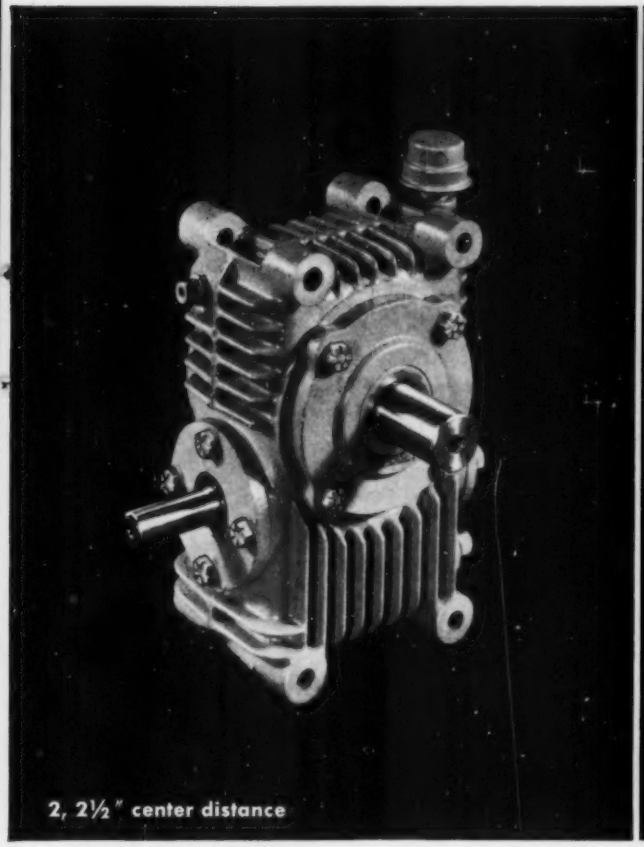
DOUBLE REDUCTION

DOUBLE-EXTENDED WORM SHAFT

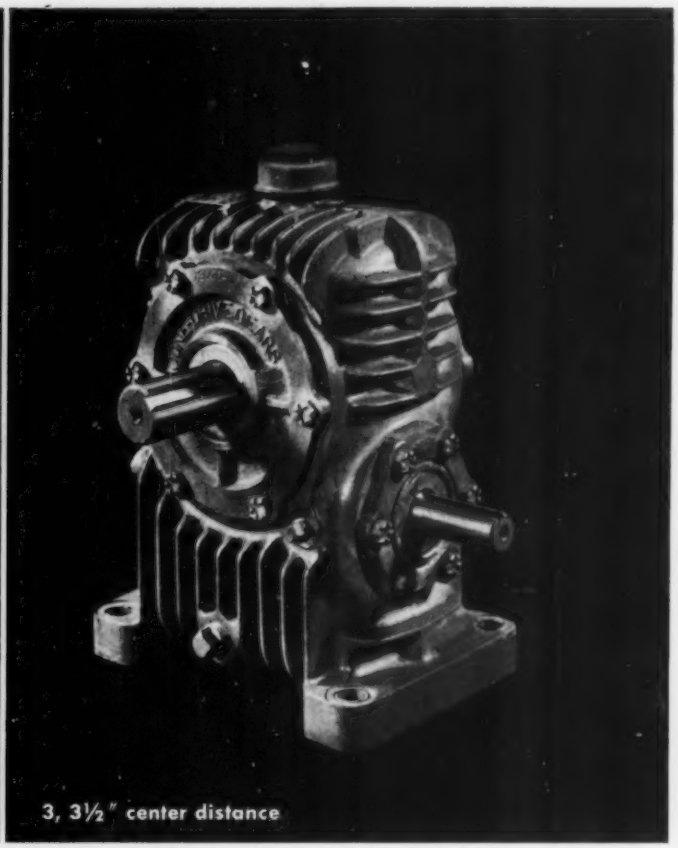


GEARSETS & MOUNTINGS





2, 2½″ center distance



3, 3½″ center distance

Custom-build Your Worm Gear Drive from . . .

OVER 200,000 STOCK

The four "worm-under" speed reducers shown above represent only eleven sizes of standard, Cone-Drive units. Also standard are 15″, 18″, 22″, and 24″ center distance units. Cone-Drive worm gear reducers are available in ratios from 5:1 to 4900:1 and up to over 1200 HP capacity. All units feature the double-enveloping principle in which the worm and gear wrap around each other for greatest tooth contact, strength, smoothness, shock-resistance and quietness of operation.

All Cone-Drive worm-gear reducers feature heavy, ribbed, nickel-iron castings for maximum strength and heat dissipation. Heavy-duty taper roller bearings provide anti-friction support to both worm and gear shafts. Chrome-molybdenum-nickel steel worms and tin bronze gears provide long life and high strength. The Cone-Drive design also gives the exclusive benefit that, in service, both gear and worm tend to regenerate their true form . . . worm and gear wear "in" rather than "out."

Standard Options

By selecting various options, standard units can be obtained to fit almost any drive requirements. By taking advantage of these options in the early design stages, you can often simplify design and improve performance, too. Including size and ratio ranges and options available, Cone-Drive Gears offers over 200,000 worm-gear speed reducer combinations that are standard, shelf-hardware items. Special sizes and ratios can be furnished on a quotation basis. Write for Bulletin CD-218 for complete details.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS

DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

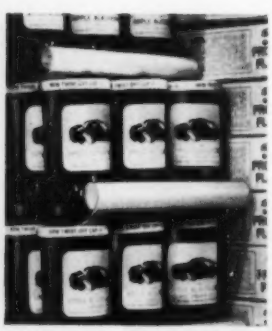
DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

Tough, durable Mylar® cuts costs... improves product performance

1. Conveyor belts of "Mylar" are easy to install, need fewer replacements, are easy to keep clean . . . cut "downtime," reduce costs.

2. Age-resistant recording tapes of "Mylar" won't ever dry out or get brittle . . . are highly stretch- and break-resistant . . . assure lasting fidelity.



3. Roll-back shelving of "Mylar" gets rid of retail stacking and stocking headaches. As shoppers remove items, "Mylar" rolls back.

For example, "Mylar"* polyester film gives many products extra resistance to chemicals, moisture and aging . . . lengthens their life. Today, "Mylar", with its high tensile strength in thin gauges, is improving the performance of products as different as wire and cable tapes and loose-leaf-sheet protectors.

Can this unique plastic film and products made with it help you? For more information on "Mylar", write the Du Pont Company, Film Dept., Room S-8, Wilmington 98, Delaware.

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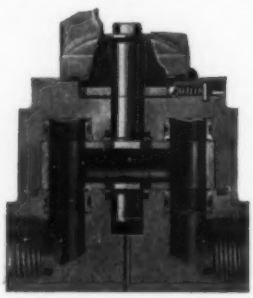
2, 3, 4-WAY SELECTOR 6000 psi

REPUBLIC LO-TORQ SELECTOR VALVES

Design of the Lo-torq Seals provides perfect sealing under full pressure, reverse pressure, or no pressure in indexed positions. As line pressure increases seals become tighter, yet by use of the exclusive balanced step design, excessive friction is eliminated, and the remaining pressures counteract upon both sides of the valving disk. Result — low turning torque, with no leakage. Interflow and non-interflow models. Side, bottom or sub-plate connections. Pipe or tube, ⅛ to 2 in. Readily panel mounted. Low and high pressure types. Air, gas — 2000 or 4000 psi max. Fuel, hydraulic oil, petroleum, water — 3000 or 6000 psi max.



SECTIONAL VIEW OF LO-TORQ VALVE

LO-TORQ SUB-PLATES

Republic Sub-plates provide a simple and quick way to mount valves. Without disconnecting lines, valves are removable for service or replacement. Bottom or side ports, pipe or tube up to 1 in.

3000 psi Mini-Lo-Torq

Miniature Selector Valve for directional control of small amounts of fluid at high pressures, for pilot control, and where space is at a premium. Maximum service 3000 psi, hydraulic or pneumatic. 2, 3, 4-way, ⅛ and ¼ in. pipe or AND10050 tube ports. Panel mount Aluminum alloy.

10,000 psi Lo-Torq

Lo-torq Seals give leak-tite service in oil, air or water use up to 10,000 psi. Low turning torque. Additional control valves not needed. Body and internal parts, stainless steel. Panel mounting flange. 2, 3, 4-way, with ¼ to 1 in. internal pipe or AND10050 ports, standard. High pressure tube ports on special order.

RELIEF • CHECK • NEEDLE • PLUG • SOLENOID • MANIFOLD • GLOBE • SPECIALS

Republic produces several complete lines of pneumatic and hydraulic valves in sizes up to 2 in. Special valves and components engineered and manufactured to customer's specifications. Please consult us.

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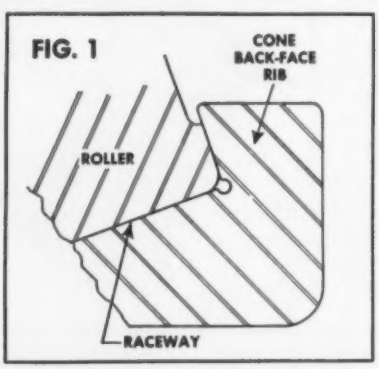
BEARING BRIEFINGS

BEARING GEOMETRY MAKES OR BREAKS BEARING PERFORMANCE

To develop high capacity and optimum performance in a tapered roller bearing, it is essential that roller alignment be accurate. Correct roller alignment, in turn, depends on a critical geometric relationship between the cone back-face rib, and the cone raceway.

Perfection in this geometric relationship compels the rollers to align themselves perfectly with respect to the bearing geometry, and each roller shares equally in the work that is imposed. Figure 1 diagrams the important elements involved.

When this rib-to-raceway relationship is incorrect (because of either faulty bearing design or manufacturing inaccuracies), rollers experience misalignment and begin to skid and skew under load. As engineers know, poor performance and premature bearing failure are inevitable under these conditions.



In the design and manufacture of Bower tapered roller bearings, Bower engineers take great care to generate and hold an exact face angle on the cone back-face rib. In practice, this means that Bower bearings are designed for maximum life and optimum performance under any operating conditions. It means that Bower bearings retain accurate roller alignment under all speeds and loads up to the maximum for which the bearing is rated.

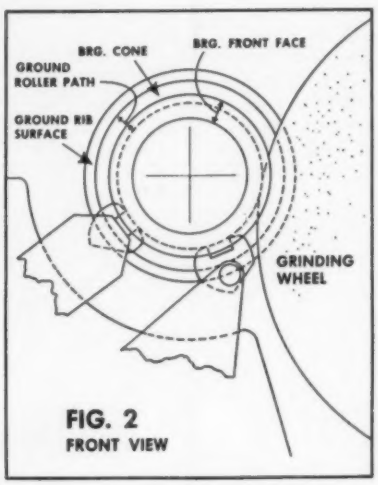
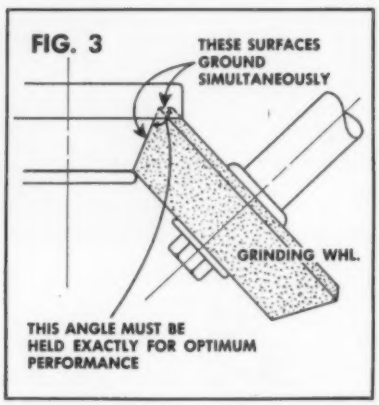


FIG. 2
FRONT VIEW

It's one thing to develop proper bearing design on paper, but quite another to carry it out consistently in manufacture. To this end, Bower engineers were instrumental in the design and development of a unique centerless grinder on which Bower precision grinds each bearing's cone raceway and rib-face simultaneously. The results obtained from these machines invariably meet or surpass Bower's exacting requirements and assure perfect roller alignment.

Figures 2 and 3 are front and top views which illustrate Bower's technique of centerless grinding rib-faces and cone raceways together. As a result, every component in a Bower bearing is perfectly concentric about its rolling axis.



★ ★ ★ ★

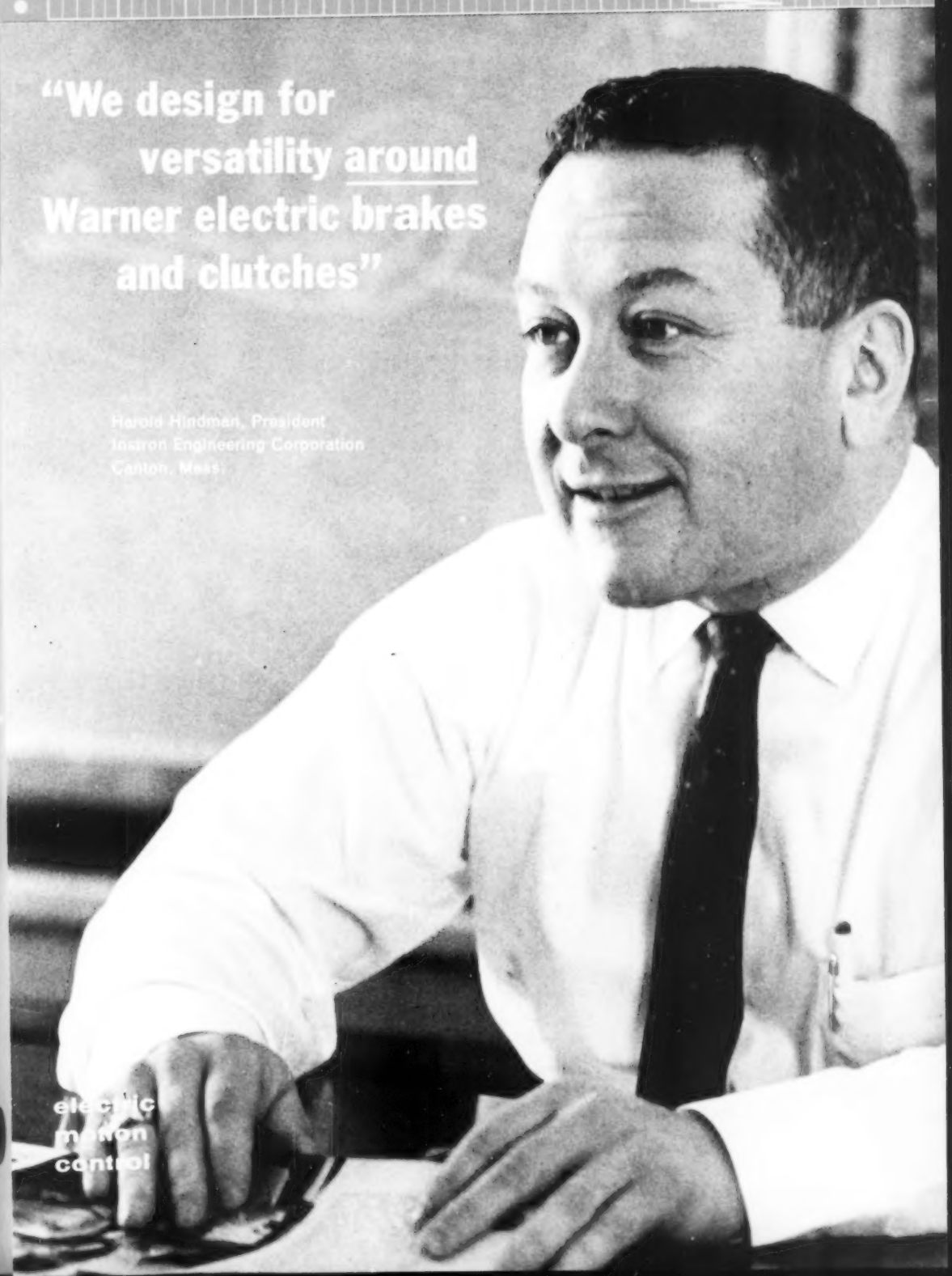
When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN

CIRCLE 67 ON READER SERVICE CARD→

Product Improvement Ideas from WARNER ELECTRIC

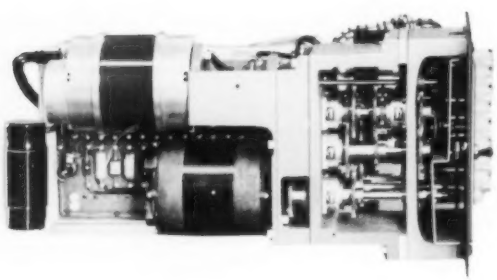

"We design for versatility around Warner electric brakes and clutches"
Harold Hindman, President
Instron Engineering Corporation
Canton, Mass.
WARNER ELECTRIC

Don Erb, Chief Engineer—Develops needs into wants.

Torey Montesi, Purchasing Agent, Production Manager, and Plant Superintendent—Warner value analyst, from receiving room to shipping platform.

Warner Sales Engineer, Torey Montesi, and Don Holmes, Design Engineer—Search is for standard components built by specialists.

Larry Cedrone, Custon
Encourages customer to



Warner electric brakes and clutches keep Instron designing ahead of industry

The gentleman who wrote: "Build a better mousetrap, and the world will beat a path to your door," sloganized a now trite but obviously sound marketing philosophy.

Instron Engineering Corporation makes this formula work. Executives of the Canton, Mass., firm plan their industrial instrument line around self-established criteria of good testing methods...almost disregard conventional concepts and equipment.

In doing so, the principles of Warner electric motion control have provided a lush feeding ground for Instron engineers eager to find new ways to increase versatility and automaticity of their equipment. Result: Valuable new tools and techniques for industry—and a growing number of customers following the path to Instron's door.

Here are specific product improvements stemming directly from Warner electric brakes and clutches:

1. *Increased accuracy*—Four-millisecond actuation of interlocked electric brakes and clutches improves control.

2. *Prevention of obsolescence*—Compact electric brakes and clutches permit new components to be designed as plug-in attachments for machines in the field.

3. *Increased productivity*—Pushbutton control speeds operation, makes statistical testing economically feasible.

4. *Versatility*—Direct electrical actuation of clutches simplifies control of selsyn drive from a low-power reference unit.

WARNER ELECTRIC

Leo Quintiliani, Buyer, and **E. J. Tolle,** Sales Manager—Customers find uses they never dreamed of.

Customer Service Manager—
mer to learn by doing.

George Burr, Vice President and Secretary—Warner distribution serves Instron overseas.

5. Foolproof operation—Simple electrical interlocking of clutches and brakes guards against machine damage.

6. Reduced cost—Eighteen different speeds can be pushbutton-selected by direct actuation of clutches in new quick-change drive. Complex mechanical linkages and controls are eliminated.

By keeping design pressures on versatility and automaticity, Harold Hindman, President and co-founder of the company, has catapulted Instron into leadership in just 14 years. Applications for Instron testers have expanded into quality control, as well as to complex materials testing and research in various industries.

Design Engineer Don Holmes credits Warner Model 100 units for adding important sales advantages to the Instron line. Eleven flange-mounted clutches are mounted in a compact quick-change drive (left) which provides 18 different speeds in two ranges to the servo-mechanism. The technician just pushes a button to change speeds.

George Burr, Vice President and Secretary, visualizes the quick-change feature as especially valuable in the chemical and plastics industries. With quickly changeable speeds, a specially equipped Instron Tester can be made to simulate injection-molding equipment.

Elimination of time lag for engaging and disengaging direction of travel, in stopping movement, and in recording test data is a critical requirement at Instron. Since Warner electric brakes and clutches require only four-millisecond response, they have become an important part of Instron's new product and product improvement programs. But most important, direct electrical actuation simplifies automatic operation, permits integral control of remote integrator or recorder and tester, and provides a ready-made system for interlocking machine motions and preventing damage.

Precision instrument buyers look at controls first, so why not put proved performance where your customers see it?

Electric motion control by Warner is pioneering new concepts for nerve centers in machine design. Brakes and clutches you can hold on the tip of one finger easily control: no-load starting, multiple-drive synchronization, rapid cycling, fine-increment inching and jogging, rotary and lineal positioning, foolproof interlocking, and many other machine functions your customers look at first when purchasing or replacing equipment. That's why a Warner sales engineer can be a valuable contributor to your product improvement program.

WARNER ELECTRIC

Warner Electric Brake & Clutch Co.
Beloit, Wisconsin

planning and doing

the BOAR and the FOX

A wild boar was sharpening his tusks against a tree. A fox passing by asked the boar why he did so. "I can see no reason why you sharpen your tusks," said the fox. "There are no hunters around, or any other dangers near us that I know of." // The wise old boar kept rubbing his tusks and replied: "Quite true, my friend, but when danger does come, I will have other things to do than sharpen my tusks."

moral: Today's planning is tomorrow's performance.

While you plan tomorrow's tooling, take a sharp look at your cylinders. High cost of machine time demands reliable performance from such components in order to compete profitably. Hydro-Line cylinders have two important new advantages to help keep your machines performing at peak efficiency, tomorrow *and* today.

Rod seals and wipers for our series N2 cylinders are made from Du Pont's Viton® — unsurpassed for resistance to heat and hydraulic fluids. (Viton seals and wipers are optional, at slight additional charge, on series R2 cylinders.)

Chrome-plated barrels for Hydro-Line air cylinders withstand scoring on the most rugged applications. These hard chrome-plated barrel inside diameters also resist corrosion and wear to help you avoid costly downtime and missed shipping dates.

Look in *Sweet's Product Design File* for dimensions of our standard stock cylinders, ready for off-the-shelf delivery. Check the address of your nearest Hydro-Line representative. Then ask him to help you select the correct cylinder for hydraulic applications to 5000 psi and air operations to 200 psi.

Viton is a registered trade-mark of E. I. du Pont de Nemours & Co. (Inc.)

HYDRO-LINE

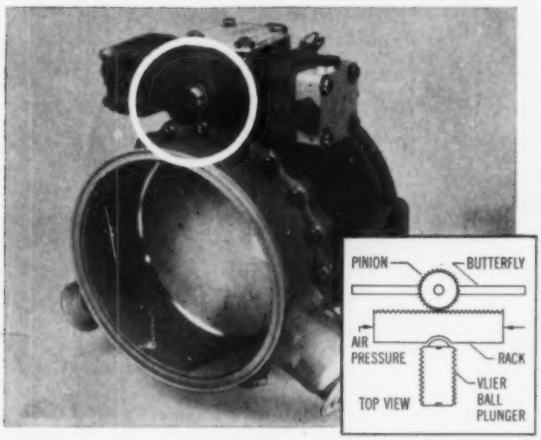
HYDRO-LINE CYLINDERS

5600 PIKE ROAD • ROCKFORD, ILLINOIS manufacturers of:
high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustable-stroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • booster cylinders

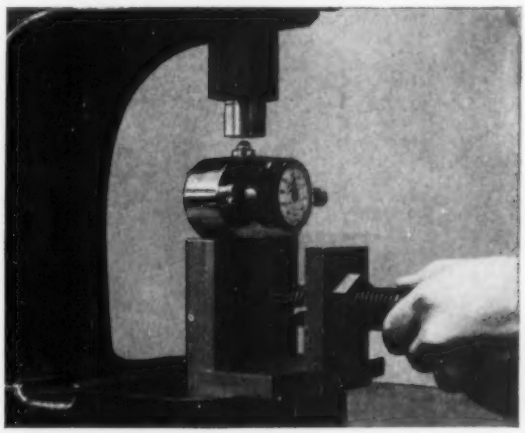
Practical Design Tips

No. 6 of a series

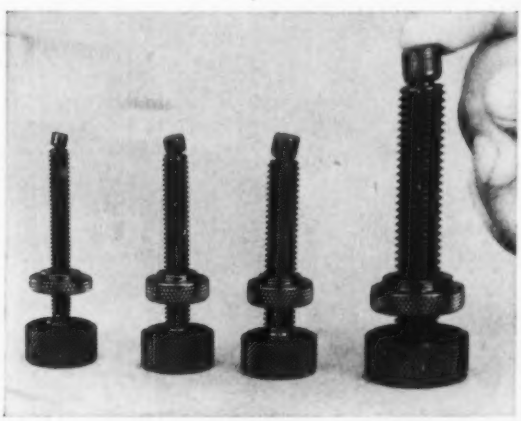
If the profit squeeze is making you look for new ways to reduce costs, look into Vlier products such as those shown below. Hundreds of companies are using these simple, standard parts to replace complicated, specially-machined devices—usually at a fraction of the cost.



SPECIAL VLIER BALL PLUNGER used on this Hermetic Barrier Valve detents on a rack which controls a pinion, which in turn, operates the butterfly. Air pressure forces rack out of detent, opening or closing valve. Plunger, therefore, acts as a positive stop until air pressure is great enough to force shaft past detent. Vlier Ball Plungers are available as standards in sizes from 4-48 x 3/16" to 5/8-11 x 1". Various end pressures. Specials on quantity orders.



SPECIAL VLIER SPRING PLUNGER, shown in test fixture, has laminated phenolic plunger to conform to MIL-P-79B (Type GMG). 1¼" plunger travels .890"; absorbs side load of 105 ±20 pounds. Vlier can provide spring-loaded devices with various diameters, end pressures, plunger lengths, and made of materials to meet your specifications.



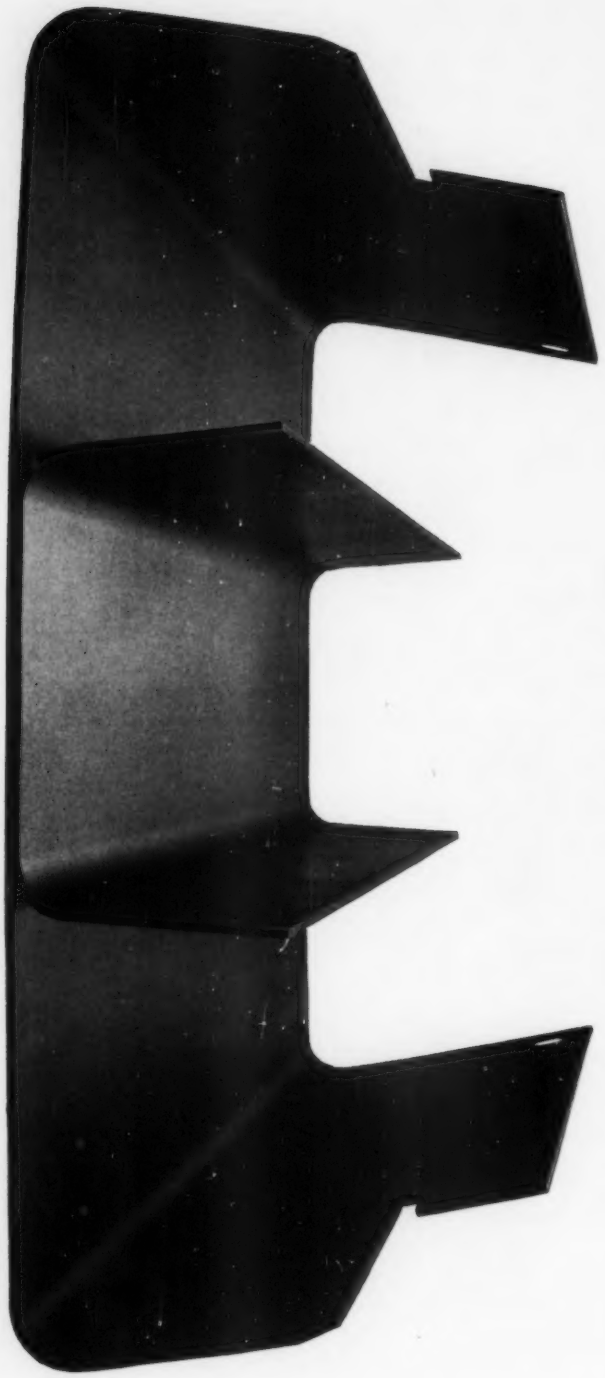
NEW CONTROLLED-TORQUE TOOL incorporates a swivel-pad on the screw end to protect surface of part being held. Pad swivel 7½° in all directions to accommodate off-angles. Has unique ball-joint construction for smooth operation. Named the Vlier Torque Thumb Screw Swivel-Pad Clamp, they are available as standards in ¼-20 x 2¼", 5/16-19 x 2¼", 3/8-16 x 2¼" and ½-13 x 3".

FREE IDEA BOOKLET—16 pages crammed with photographs showing how others have profited by designing standard Vlier parts into their products. Your Vlier distributor will be pleased to give you a copy, or if you prefer, write directly to us.

VLIER
Engineering Corporation
A subsidiary of Barry-Wright Corporation
8900 Santa Monica Blvd., Los Angeles 46, California

←CIRCLE 70 ON READER SERVICE CARD

CIRCLE 71 ON READER SERVICE CARD 71



Practical approach to compactness is demonstrated by this flame retardant, interphase insulating barrier for magnetic air circuit breakers. When the equipment was designed, CDF utilized its extensive knowledge of adhesives and post-forming to provide the barriers from a flame retardant, paper base phenolic laminate.

Result: two pieces bonded together to provide three channels in one unit, reducing size and cost, yet maintaining effective electrical insulating properties.

A few facts on the laminate:

Flame resistance: ASTM D-635	... self extinguishing
Water absorption, %	1.8
Flexural strength, psi	12,000
Specific gravity	1.38
Dielectric strength, parallel, kv	40

CDF® CONTINENTAL-DIAMOND FIBRE

CONTINENTAL-DIAMOND FIBRE CORPORATION, NEWARK, DELAWARE • A SUBSIDIARY OF THE Bndd COMPANY

...the ultimate in motor winding protection!

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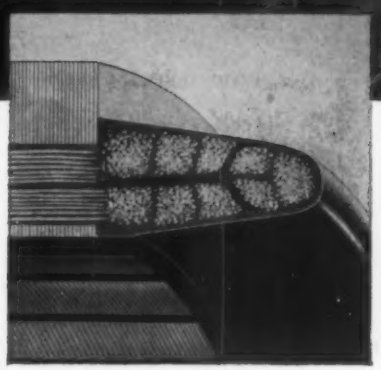


Note complete coverage and protection provided by molded end-turn construction.

U.S. ELECTRICAL MOTORS INC.

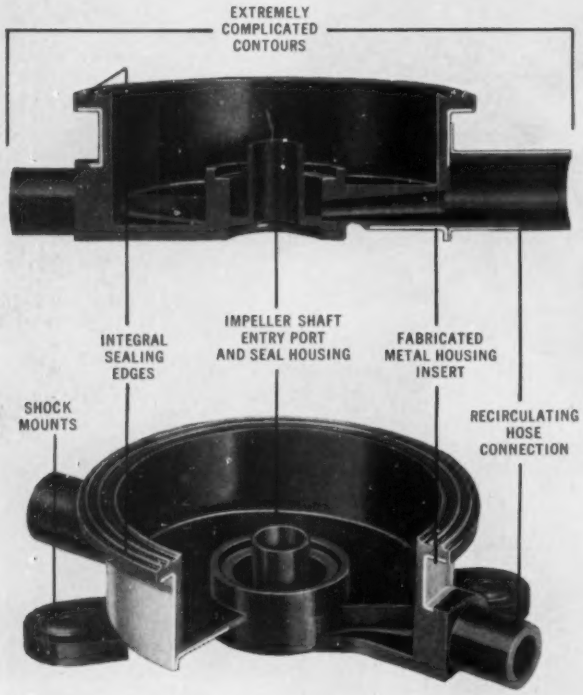
P.O. Box 2058 • Los Angeles 54, California or Milford, Connecticut

US MOTORS

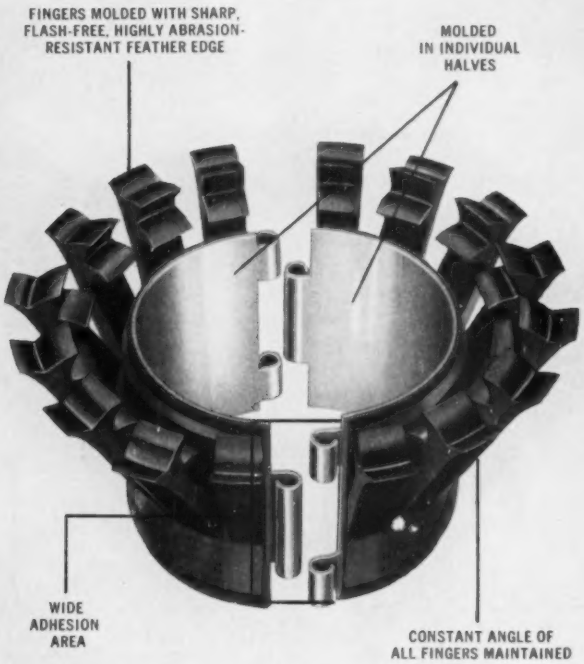
CIRCLE 73 ON READER SERVICE CARD

OHIO RUBBER

"CUSTOMEERED COMPONENTS BASIC TO INDUSTRY"



DISHWASHER PUMP IMPELLER HOUSING—part for major household appliance manufacturer. **Problem Solved:** Intricate precise, compression molding and uniform rubber adhesion to fabricated metal insert. Constant, residual water, at varying temperatures, made absolute adhesion mandatory to prevent seepage and corrosion. Stock had to be non-absorptive, non-swelling, heat, ozone and detergent proof. ORCO designed, built, and maintains the molds—delivers consistent, high-quality rubber adhesion on a production line basis to rigid, quality-control standards.


FINGERS MOLDED WITH SHARP, FLASH-FREE, HIGHLY ABRASION-RESISTANT FEATHER EDGE
MOLDED IN INDIVIDUAL HALVES
WIDE ADHESION AREA
CONSTANT ANGLE OF ALL FINGERS MAINTAINED

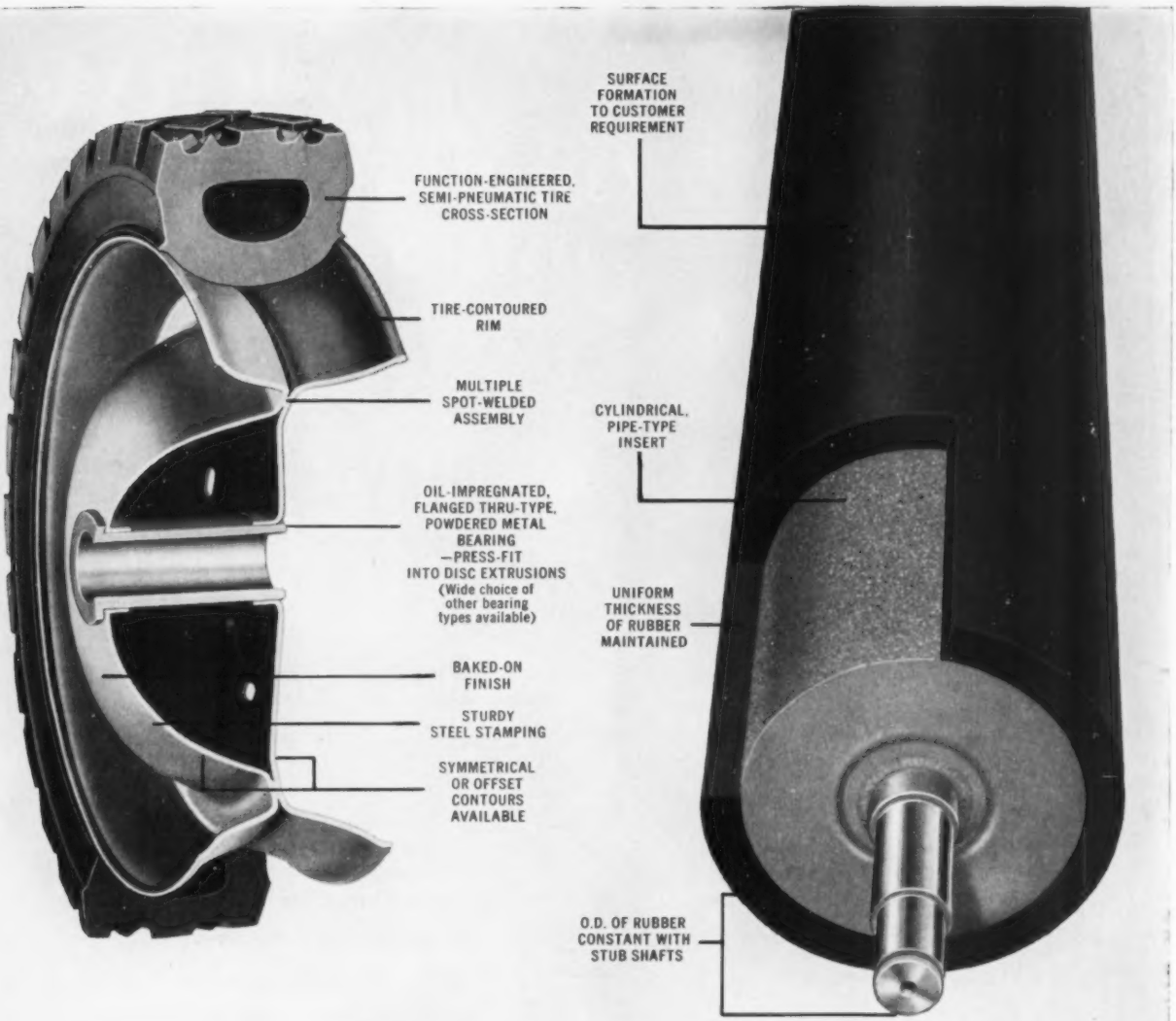
"RECIPO" OIL WELL WALL CLEANER—removes filter cake, mud, and foreign objects from bore hole. **Problem Solved:** Compression mold and bond-to-metal very flexible, high tensile, top quality natural rubber stock to extremely critical customer specifications. Design, build, operate, and maintain highly intricate molds to operate on normal production basis. Safeguard part against tremendous high stress concentration by engineering permanent, dependable, rubber-metal adhesion.

How ORCO "customeered® rubber parts

OHIO RUBBER IS THE GOOD SOURCE FOR THE O.E.M.!

As a "manufacturer's manufacturer", the OHIO RUBBER Company regularly serves, as above, many diversified industries and operates five, major, geographically-strategic plants to do so. From its facilities in depth, ORCO can—and does—deliver large quantities of natural rubber, synthetic rubber, silicone rubber, flexible and rigid vinyl, and polyurethane component parts—all "CUSTOMEERED" to your specifications.

To better serve the O.E.M., OHIO RUBBER designs, builds and maintains precision molds and dies . . . performs permanent bonding-to-metal . . . delivers injection, vacuum, compression, transfer, and automatic continuous moldings, as well as extrusions. And, all are backed by continuous statistical quality control, coordinated production control—and supervised by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TIRE-CONTOURED RIM
MULTIPLE SPOT-WELDED ASSEMBLY
CYLINDRICAL, PIPE-TYPE INSERT
OIL-IMPREGNATED, FLANGED THRU-TYPE, POWDERED METAL BEARING —PRESS-FIT INTO DISC EXTRUSIONS (Wide choice of other bearing types available)
UNIFORM THICKNESS OF RUBBER MAINTAINED
BAKED-ON FINISH
STURDY STEEL STAMPING
SYMMETRICAL OR OFFSET CONTOURS AVAILABLE
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QUALITY SEMI-PNEUMATIC TIRES AND WHEELS—working components for movable equipment. **Problem Solved:** Provide a reliable source in depth for standard duty, industrial duty, and special duty wheels with accessories—all equipped with a wide range of job designed and proved tires and treads to meet customer applications. Wheels and tires are load and speed rated; field and laboratory tested. Full line available. Custom requirements can be met. Engineering and technical service offered.

HAY CONDITIONER ROLL—integral component for agricultural equipment manufacturers. **Problem Solved:** Maintain uniform adhesion of 6′ long, inch-thick, rubber blanket molded on cylindrical, customer-furnished insert. Surface configuration of roll to vary according to customer's specifications. Stock, field and lab tested, must be highly abrasion-resistant—yet resilient enough to cushion impact and passage of incidental debris without interfering with continuous conditioning function of roll.

aid product design

laboratory and engineering staffs second to none!

If you have a part that may work better as rubber, or with rubber, ORCO is eager to serve you. For complete details, at no obligation to you, write or phone us, today!

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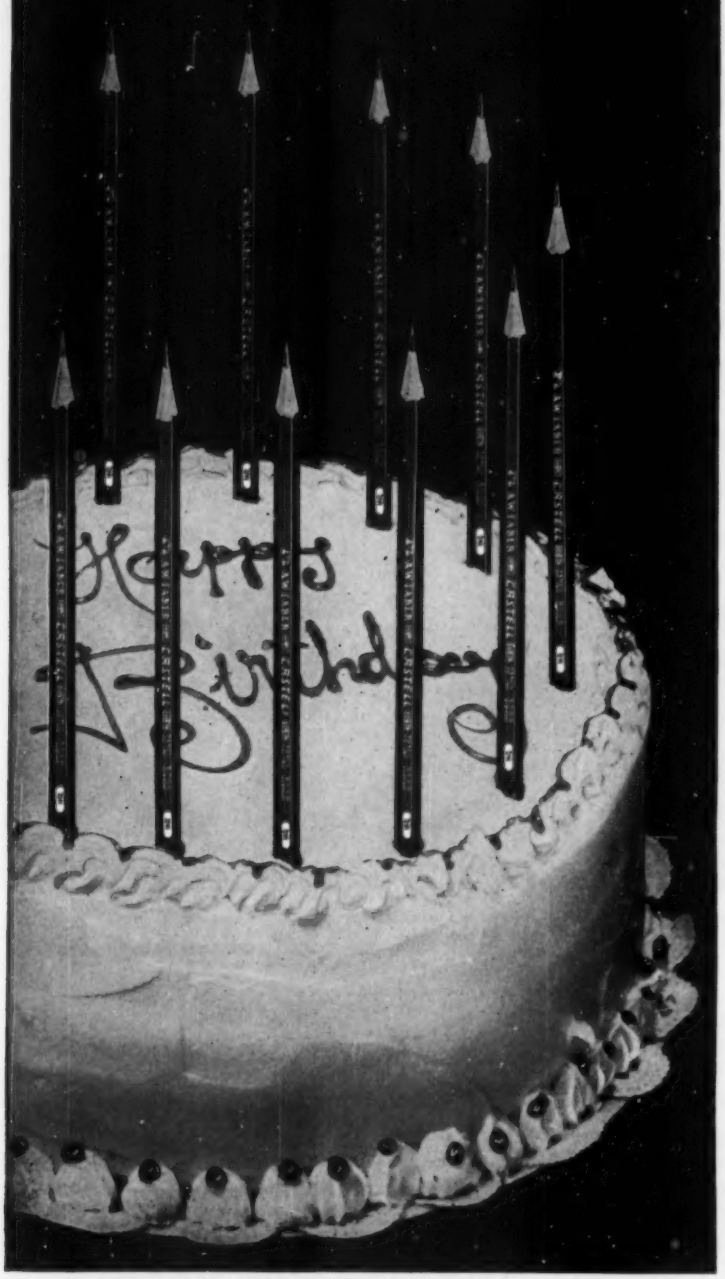
200th Birthday

OF A.W.FABER-CASTELL ...

Producers of the nearest thing to perfection in a drawing pencil



It is customary, on the occasion of a company's bicentennial, to talk about the traditions that made it great.

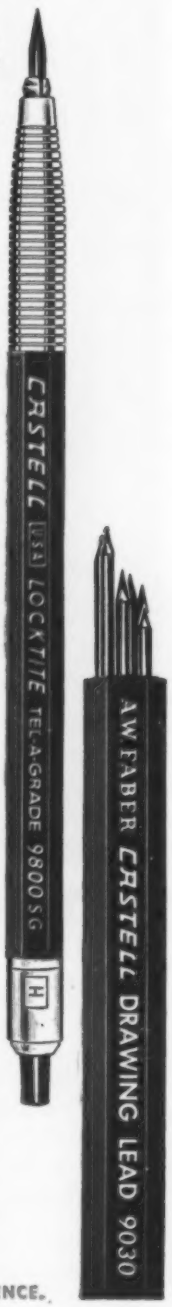
Nothing would make us happier than to talk about A.W.FABER-CASTELL's distinguished history. But it may be more important if we pointed out how CASTELL drawing pencils can further your career.

CASTELL's Black Gold graphite allows a creative man to express his profoundest ideas. It gives such a bold, black image, such density saturation, that sharp, crisp drawings are assured. Its light-proof adhesion produces the highest number of sharp prints per drawing — without loss of detail even after hundreds of reproductions.

CASTELL's low index of friction gives you smooth, chisel-point strokes and needlepoint for the most exacting detail. Its close-textured lead has great strength. The lead won't crumble, the wood won't splinter, even under heavy pressure.

CASTELL is consistently uniform — identical in every degree, from 8B to 10H. You can go back to an unfinished drawing months — even years later — without change in line width or color.

Because of this unvarying excellence, CASTELL is the nearest thing to perfection man has ever put into a drawing pencil. For the sake of your own career, you'd be wise to join the A.W. FABER-CASTELL family.



For those who prefer a lead holder, **#9800 SG Locktite Tel-A-Grade,** *with no-slip, functional grip gives you smooth traction and blessed comfort to your tired fingers* ■ **Castell Drawing Leads #9030,** *of identical quality and grading as Castell drawing pencils* ■ *Usable in all standard holders, but a perfect mate for Locktite* ■ *Available in a full range, from 7B to 10H, and a kaleidoscope of colors* ■ *Draws perfectly on all surfaces, including Cronar and Mylar base films* ■

A.W.FABER-CASTELL Pencil Co., Inc., Newark 3, N. J.

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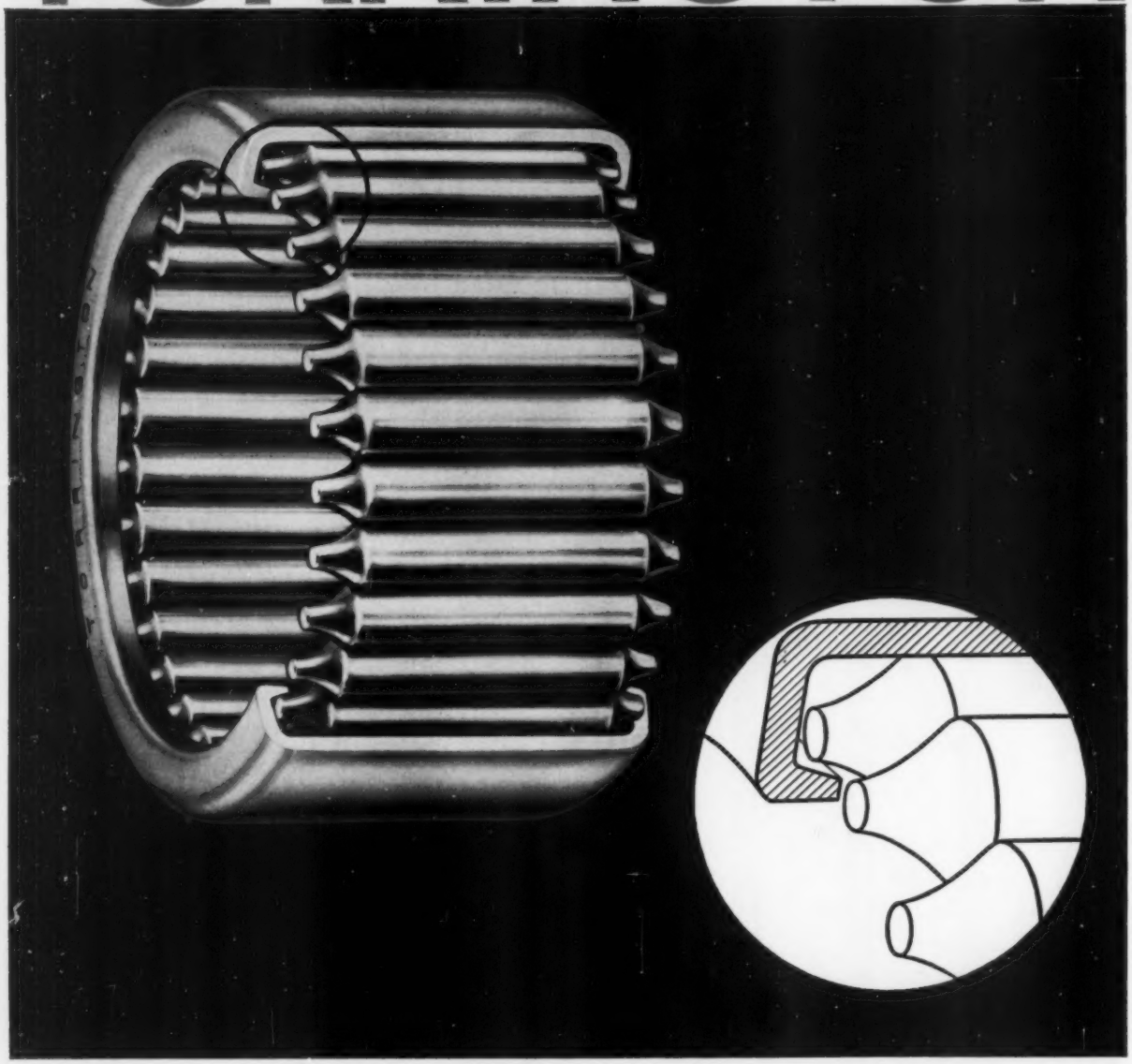
TORRINGTON



NEVER A SLIP 'TWIXT THIS CUP AND LIP

The Torrington Drawn Cup Needle Bearing is one of the easiest of all bearings to install and maintain. Secret is the turned-in lip construction. This lip positively retains the rollers... keeps them in position as a complete unit during all handling and assembly operations. Install it by simple press fit. No snap rings or shoulders are necessary.

That's not all. The Torrington Drawn Cup Needle Bearing also gives you a higher radial load capacity than any other bearing of comparable size. Precision rollers insure smooth, highly efficient performance, with a minimum of starting and running friction.

This bearing is compact, lightweight, economical. Its unit cost is surprisingly little. For details on how the Torrington Drawn Cup Needle Bearing can help your product, call or write Torrington... pioneer in needle bearings and maker of every basic type of antifriction bearing.

progress through precision

THE TORRINGTON COMPANY

TORRINGTON BEARINGS

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PRODUCT ENGINEERING
SPECIAL REPORT

ALUE . . .

the emerging emphasis in design

A study of present and future potentialities of specialist services in design engineering—reliability, value analysis, value engineering, quality assurance and the like, based on interviews with and comments from some 80 men, many of them engineering executives. Among the questions answered here: What do these services provide? How do they do it? At what cost? Why? How do these services differ and how do they interrelate? Why should I be interested? What can they do for me?

E J TANGERMAN, *chief editor*

THE RETURN TO VALUE

Ask an engineering executive today what worries him most and he'll say "Costs!" Ask the same question of a company executive or the head of the family and you'll get the same answer; costs are everybody's headache.

Even in missiles, the current "cost-is-no-object" field, federal pressures have resulted in what is called the area's "fastest-growing industry —unemployment." Cost reduction has resulted in slashing of engineering staffs as well as production forces, for massed engineers (some doing technician jobs) do not achieve efficiency; further, computers and other aids to calculation and analysis have reduced requirements for men.

Increasing foreign competition, using our methods, will force a continued searching examination of costs. Some elaborate R & D setups are being viewed with a critical eye, and some development is currently being imported. But now the paradox . . .

Specialist departments are being organized for reliability, value and engineering, expanded quality control, quality assurance and value research. Today, most engineers face a rise in "over-the-shoulder" advisers, an increase in organizational complication and costs—at the same time they

are asked to cut costs. They see added confusion and elaboration where the obvious need is for streamlining and simplification; they see pre-emption of their responsibilities by other groups which often include non-engineering personnel.

Why?

In some cases (too many, in fact), the pressure is for pure cost-cutting. In the enlightened cases, the effort is to achieve value—to hold costs down without sacrifice of quality—or more properly, to balance cost and performance, to attain the integrity that the customer now demands.

We have always had specialists within the engineering department, in materials, stresses, kinematics, even though every engineer has basic training in these fields. So we should expect specialists in reliability, value analysis, quality control, value assurance—areas where most engineers have limited training, if any. If one kind of specialist can improve the design and save money in the long run, why not the other?

The problem is not simple. Beyond the organizational difficulties, the irritation of "second-guessers" and "arm-chair admirals," is the hard fact that these relatively new specialist services are paying their way. Value analysis in the Navy is currently paying out at 16:1. Reliability has gotten a much higher percentage of missiles off the launching pad. The armed services are so convinced of the value of value engineering that they offer their contractors 40% of first-year savings.

Beyond all that, the key to survival, of a nation or a company, is technological innovation; and the pressure of cost reduction encourages innovation. But no cost-cutter can ever pre-empt innovation—the basic function of the engineer.

THREE QUESTIONS

We asked engineering executives in 55 companies:

1..What changes are taking place in organization and responsibilities of engineering departments?

2..Will Engineering have responsibility for quality control,, reliability, and value engineering?

3..What organization is needed?

ENGINEERING ORGANIZATION STILL IN TRANSITION

■ The last decade has brought a bewildering array of "scientific" management concepts that apply directly or indirectly to Engineering. Coupled with this has been a sharp increase in the amount of engineering in the product and faster development of new materials and processes. Along with the tendency of big companies to get bigger, these conditions are resulting in much larger engineering departments, with more complex functions and the necessity for new procedures in organization and cost control.

In Inspection, for example, the simple and straightforward process of comparing product with standard has changed radically. First, tolerances and dimensions became closer, so the instruments for inspection became more elaborate. Next, high-production machines were built to hold a setting or adjustment for long periods of time, so simple parts were more uniform. This led to statistical quality control with 100% inspection replaced by sampling.

Then, there were problems of dimensional drift and its causes, redesign to avoid inspection failures, and objective analysis of rejects that pushed Quality Control in the direction of Engineering.

In similar fashion, a number of other developments have had an impact on Engineering. Under such names as value analysis, value engineering, quality assurance, cost reduction, reliability, some have been championed by the military, others have ranged from vogue to value. Last May 16 we took a close look at Reliability.

To evaluate the importance of these continuing trends on Engineering, we more recently made both a mail and a person-call study among chief engineers and vice-presidents of engineering. We sampled both large and small companies, coast to coast; a few in the military and missile field but most in cost-sensitive industries—nearly 60 in all.

In the summaries that follow it is immediately

obvious that, in addition to differences created by size and individual organizations, there are also differences caused by type of product and volume of production.

We asked three questions:

1. How are engineering departments and their responsibilities changing? Where are they going?

2. Will Engineering have responsibility for reliability (R), Quality Control (QC), Value Analysis (VA), Value Engineering (VE) and similar specialty groups or programs?

3. If so, where will the responsibility be placed? What organization is needed?

Answers to the first question were basically the same we found two years ago, reported in "Engineering Organization in Transition" (*PE—May 11 '59, p 47*). There is no single preferred organizational structure; the form is secondary to many other factors, such as the people, products, policy and volume involved.

Within a company it often differs, product by product, plant by plant, or division by division. But the earlier trend of separating engineering effort into R & D and Product Design department is being modified by a further separation of product design and production design.

Product design grows in emphasis

We find increasing emphasis on a 3-part division such as Advanced Planning, Product Design, and Test; or Research, Development and Design, and Test; or Research, Development, and Design (really Redesign). In still other cases, the sub division is into Research, Development, and Product Engineering, the latter meaning engineering for production. Sometimes, it includes functions previously considered as part of production engineering, such as tooling and programming; in other instances it includes all of production engineering. The objectives behind such organizational changes usually are optimum quality and cost.

What they tell us

Behind it is an evident change in emphasis—a shift which one engineer describes as from "product orientation" to "customer orientation"—a reawakening of a spirit of integrity, a reacceptance of the fact that the customer must be pleased with his purchase if the seller's long-term future is to be assured. **There is a growing recognition of the importance of value.**

Says another engineer, in a consumer-product plant: "Organization is irrelevant unless technological and social progress serves the needs and wants of the customer. Too often the tendency is to solve everything by organization, losing sight of the real objective, a satisfied and lasting customer."

In another instance, an over-grown "brain factory" that delivered more in ideas than in hardware, the products were excellently engineered and ideas were outstanding. But the engineering drive for perfection without regard for cost made complete reorganization necessary to impose proper controls and save the company from financial trouble.

One large company formerly had an R & D department to carry a development through the prototype stage, with tested models, manufacturing drawings and parts lists ready to release to Production. This has been re-oriented by establishing a plant-by-plant function called Product Engineering which handles:

1. Final development of the product—production design, tooling, methods of fabrication, assembly processing. However, R & D is required to make preliminary cost estimates.
2. Product improvement, even though this involves function of the product or parts.
3. Cost reduction on existing products.
4. Tool design, production engineering and process engineering.

In this setup, Quality Control remains in manufacturing and reports to the plant manager, but R & D has a department called Reliability Engineering that includes a testing lab for service to R & D and Product Engineering. It makes tests on materials and components, conducts Underwriters and government tests, R analysis and statistics, and quality assurance tests (on an auditing basis). A director of Quality, Products & Services reports to the president; he has no test labs or other physical setup; instead, he uses QC organizations in plants and R in the engineering dept to develop information, plus reports from field and service organizations.

The general effect is to assign out functions locally, with Engineering having responsibility for technical coordination, interpretation, standards and the like. Advanced design (or R & D) is corporate so it can coordinate the work of Product Engineering groups but is not responsible for control of production. It thus is a logical place for the R group.

An interest but contrasting opinion is presented by another engineer: "It is somewhat analogous to our form of government, in which we have a Congress (Engineering) to make the laws but other agencies to implement and enforce them. Some very desirable checks and balances are provided by having Purchasing, Manufacturing and Quality Control of an equal organizational stature with Engineering. These other functional elements have a responsibility to maintain and, through feedback, help improve the parameters established by Engineering; but the control and integration of these activities is the function of Management, not Engineering."

One company that makes portable tools has reoriented into a 5-part engineering setup:

1. Engineering Research—really "Cloud 9" concepts, new ideas and products.

2. Advanced Design—three to four years ahead on potentially marketable products.

3. Production Engineering—design for production; includes human engineering.

4. Experimental Test Department—includes field and customer tests.

5. Administration Group—also handles drawing files, drafting section, library.

This company also has non-managerial premium jobs with titles like "layout engineer," "test engineer," "senior design engineer," corresponding to General Electric's system of "consultants" —high-ranking engineers with recognition and status, but no management responsibilities.

One engineer comments that he hadn't thought of the growing need for close cooperation for what may be called Product Engineering and Production Engineering and thinks he may try a combination of the two.

A common relationship between Engineering, Reliability and Quality Control is summed up by a consultant on integrated design practices:

"The initial definition of the product which the business intends to design and manufacture, including the desired degree of perfection in terms of function and reliability and so forth, should come out of a product-planning process participated in by all the functions who will have a part in carrying out the plan. With the product requirements consistent with business goals such as the profit-investment ratio and product leadership, then Engineering and Manufacturing responsibilities for the new product are stated concisely.

"Engineering is responsible and accountable for designing a product which, if built in accordance with this design, will meet the product requirements. The design must be sufficiently complete and specific that Engineering is accountable if a product fails, unless it can show that failure is attributable to manufacturing.

"To achieve the degree of reliability called for, particularly in complex products or systems, a Reliability Engineering group has responsibility in one or more of these areas:

Engineering quality practices and standards—particularly as to life and environmental capabilities.

Engineering design reviews—to ensure use of past experience and proven procedures.

Product design evaluation—to determine if the product does meet requirements.

Mathematical techniques—for specifying, predicting and measuring product reliability.

"While these four areas are all normal responsibilities of Engineering, the Quality Control function may conduct the environmental and life tests for Engineering to conserve scarce competence or expensive facilities.

THREE INSPECTION FUNCTIONS RELATED TO RELIABILITY

1 . . Shop inspection. Largely directed to determining conformity to prescribed methods, and the accuracy of human efforts. Statistical sampling may be used to reduce the amount of inspection effort.

2 . . Statistical quality control. Analyzing and determining the adequacy of facilities and manufacturing methods, with the idea that it is "cheaper and quicker to do things right in the first place"; also that process checks should be provided at various stages to ensure that successive steps are properly taken. This is a manufacturing engineering function.

3 . . Quality assurance. Examination of resultant manufacturing quality from the customer's point of view. Involves check-inspection sampling, surveys of manufacturing information and methods, analysis of field complaints, and the like. This is inherently a design-engineering function, though it may be delegated in part to others for convenience.

4 . . Reliability, on this basis, is also a product-design function. Establishment of reliability goals is an "advanced planning," or "product planning," or "systems engineering" subfunction. Embodiment of these goals into designs is obviously a design function, while verification of attainment is a quality-assurance function.

"To control the quality of manufacture using product design specifications as a standard, Manufacturing establishes a Quality Control program for measuring, analyzing and controlling the manufacturing work. This includes incoming inspection and test plus selective testing in the factory, although the personnel for routine testing may be a part of the production organization. Since the Quality Control organization becomes familiar with the strong points and weaknesses of the product, opinions of this group can be valuable to product planning as well as to Engineering."

And there were a number of other comments with shades of meaning different in some respect from the ones we report here. But throughout, the emphasis was quite general on greater attention to value—along with an increase in the responsibility assigned to Engineering.

NEXT . . . VALUE RESEARCH

■ **Search for value and quality must begin in research**—with the initial concept for the product. Here are the thoughts of R. J. McCrory and Tom Trainer of Battelle Memorial Institute:

Value analysis is a process for finding the lowest cost for a product. Value engineering encompasses greater scope, to ensure the best performance and reliability consistent with product cost. "Value research" is the next step—the basic root of the value of a company's products.

"Value research is a diligent and systematic effort to discover facts and principles which will make a product more esteemed, more desirable, and more useful." Consideration of value must start well back in product conception and development. Research has the basic long-range responsibility for the value of a product.

Value research has three critical facets: create value in terms of function, performance, appearance, reliability, size, maintainability, and operating cost; explore alternative means having inherently higher value; apply science and technology to the development of product value.

Increased sales can no longer be stimulated to a satisfactory level by simple reductions in price. In the summer of 1960 refrigerator prices were cut to almost 50% of their normal value—yet sales continued slow. No longer, according to a study at the University of Michigan, can a merchant post a sale sign or place a few advertisements to move his merchandise. The time is fast approaching, and now exists in many industries, when the salesman must know the value of his merchandise so he can describe it in detail for the careful buyer. He must satisfy the customer that he is getting considerably more than price in his purchase.

You can no longer depend on the consumer to direct your design efforts. As explained by E. H. Land: "New products here at Polaroid are never developed because of market research or questionnaires to customers. Industry must have insight into what are the deep needs of people that they don't know they have." Value research can provide the customer with the products which will fulfill his needs, both seen and unseen.

Primary consideration is the value to the customer, not the price to the customer. Major aspects of value are performance, appearance, reliability, size, maintainability, and, of course, first cost and operating cost. Performance itself includes several aspects of value: A product can perform a function better, it can perform more functions, or perform with fewer demands on the operator. Thus, value research requires a wide variety of technical decisions and compromises.

Secondary consideration of value research is the need for a product. In most product fields, one producer will reach a level of value beyond which competitors find it difficult to establish an increment of value. In the field of small engines for example, value analysis has resulted in a cost which has captured a huge consumer market. Value engineering has weighed the cost-reliability compromises of cast-in iron liner, a chrome-plated liner, or a bare aluminum cylinder wall. Value research, however, should take a look at the overall objective of providing shaft power. Would an engine employing the Stirling cycle (*PE—April* 11 '60, *p* 17) have greater value and provide a new stimulus to sales through safety, silence, and potential low cost?

Third element of value research is to cram as much value as possible into a given product by sophisticated technology rather than by cut-and-try methods of development. Demand for increased reliability has led to need for better understanding of the processes upon which the operation of a product depends, better methods of stress analysis, and use of mathematical reliability criteria to predict and control customer satisfaction and warranty costs.

ENGINEERING ASSUMES NEW RESPONSIBILITIES

■ **The second of our three questions was:**

"Is the Engineering Department likely eventually to have the over-all responsibility for reliability, including quality control, inspection and testing, and value analysis as well as value engineering?"

A majority of engineering executives said "no" for the over-all question but there were a surprising number of "yes" answers and many qualifications. There are obviously differences of definition and interpretation—which presented a major problem in preparing this summary.

Basically, reliability as a quantitative concept today is much more familiar, formal and advanced in companies having military contracts or subcontracts, particularly those dealing with the Air Force. In fact, MIL Spec 58-10 specifically requires that the reliability function be separate.

Quality control, as a much older idea, is associated with Manufacturing, and tends to be tied in with Reliability only in terms of interchange of data and cooperation. The Reliability Group is most likely to be in or near Engineering.

Value Analysis is most often associated with Purchasing, as a cost-reduction function applied to the product after it is in production.

Value Engineering is often confused with VA, but where the distinction is clearly made, VE is considered part of Engineering, and has to do with **cost prevention**. Another definition: VA is

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a "second look" for value improvement, primarily cost-oriented; VE is cost assurance.

One authority goes so far as to say that VE at the design level may already be too late—that true value must be a key consideration in the research and development phase. So many characteristics of the design become fixed in the R & D phase that later VE and VA efforts are merely cost-cutting operations that injure quality more than they save in cost.

Personalities and relative abilities of individuals strongly affect any organization diagram, as do product complexity, precision and quantities. But the strongest factors are the amount of engineering and the rate of advance in development of the product. In products approaching stability or maturity—when the new model shows little advance over the old—the emphasis is on production and purchasing, hence VA and QC loom large. Presumably, reliability level has been well established during the development phase, so it is not a problem. A saving of a penny a unit can be a substantial, predictable sum.

Where the rate of advance is high, and the product is costly and incorporates a great deal of engineering, R is stressed far more heavily; this is reflected in executive thinking and in the organization diagram.

Differences in setup are reported at times as the result of differences in product. In one company, for example, a heavy-product department has QC and Inspection reporting to the chief engineer; in another department producing a similar but lighter product, QC and Inspection report to the works manager but take technical direction from the chief engineer—the technical direction being the stronger and more positive.

One company found it necessary to change its approach in shifting from a self-used to an outside-sale product. Quantity for the self-use product was small and QC had been "built in"—tacitly recognized but not singled out. But when the product was sold outside in larger quantities, cost became much more important, so specialist groups have been added.

DEFINITIONS

One group of department managers, after several days of conference, agreed on these basic definitions:

1 . . **Inspection** is the process of comparing the product with applicable requirements and withholding discrepant material.

2 . . **Quality Control** is the function which plans, implements, and finally determines compliance with applicable criteria.

3 . . **Quality Assurance** is the proper integration of all functions directed toward achievement of a quality product which meets contractual requirements and any other applicable criteria.

4 . . **Reliability** is the probability of performing satisfactorily a specified function under given conditions for a specified period of time.

5 . . **Value Analysis** is a technique for determining cost of achieving a given function.

6 . . **Value Engineering** is an objective evaluation of all elements of a system for the purpose of achieving the required reliability at a minimum over-all cost.

7 . . **Production Engineering** is a major element of value engineering, primarily directed toward optimizing design for manufacturing.

Additional definitions for Items 2 and 6:

Quality Control is an effective system for coordinating the quality maintenance and quality-improvement efforts of the various groups in an organization to enable production at the most economical levels which allow for full customer satisfaction.—Armand Feigenbaum

Value Engineering is an objective appraisal of all elements of the design, construction, procurement, installation and maintenance of an equipment, including the specifications, to achieve necessary **functions, maintainability** and **reliability** at minimum cost.—BuShips

VALUE ANALYSIS GROWS INTO VALUE ENGINEERING

Any design engineer will readily admit that value analysis is a good thing—in principle. But his enthusiasm often is tempered by experiences like these:

1. VA is often just an insurance program for something that the competent engineer does himself. He should have his own chance to modify designs for cost reduction—and will do it if given the chance.

2. The value analyst is second-guessing, which "anyone" can do, without full knowledge of the problem.

3. The value analyst may be the newest man in the department—or the one who doesn't fit in anywhere else—if the program is locally administered, or a non-engineer with no training with which to evaluate his ideas, if it is in an outside group.

4. A high percentage of VA suggestions are impractical, some even foolish, yet each must be checked through by Engineering, at enormous cost in time—and sometimes in delay. The cost of checking poor projects is often not assessed against the savings attained in successful ones.

5. VA is most useful in mass production, but is of progressively less value as quantities are reduced and engineering content of the product is increased.

6. Too often, VA becomes the symbol of *quality reduction rather than cost reduction.* The engineer feels that his design has been bastardized to save money.

The need to keep costs under control has led to some application of VA all through the design, by design review boards, test groups, or some other checking program within Engineering itself. Such a program, aimed at cost *prevention* rather than cost *reduction,* is particularly worthwhile where engineering content in the product is high and quantity low, so that normal processes of VA would be merely post-mortems.

Such a program is usually engineer-operated and is called "value engineering" to distinguish it from the Purchasing-supervised VA. A similar program within Manufacturing is on occasion called "value improvement," so some companies have VA, VE and VI, working in cooperation but separately administered.

With increasing frequency, men of all-round manufacturing experience and with some engineering experience are put in value engineering. They do excellent work, but the number of such men is small and the places where they can be used correspondingly great. As in other specialized services, the percentage of incompetents is high, as is the amount of smoke-screening. Sound principles of value engineering have been corrupted into a make-work, make-report technique that defeats its own purposes. At best the value engineer has a thankless job; he must have real competence if he is to balance his many opportunities to make himself unpopular.

Growth of specialist groups

A developing problem in authority is raised by several contributors. Responsibility for Reliability, for example, "is passed from department to department until it rests with the originating engineering department . . .Unfortunately, Engineering is rarely endowed with the authority commensurate with this responsibility. I believe that acceptable products are usually achieved through interdepartmental compromises and not through direct action by those in authority . . . The differences of opinion which arise when the subject of added authority for the Engineering Department is discussed need a thorough airing."

Another engineer wryly reports that in his company QC has been passed from Engineering to general management to manufacturing management– and has deteriorated at each step. Because the responsibility for quality comes back to Engineering, which specifies it in the first place, he feels that Engineering should decide whether it has been attained.

FUNCTIONS of QUALITY CONTROL

Quality Control, in the opinion of some advanced thinkers, should be divorced from routine inspection and test. Inspection must be an integral part of the Manufacturing Dept, so Quality Control can become a professional group serving both Engineering and Manufacturing. In this concept, Manufacturing is completely responsible (and accountable) for the quality of manufactured product. Engineering is held entirely responsible for the potential reliability of the design, while Manufacturing is held completely responsible for the reliability inherent in the product as delivered to the customer.

In this concept, Quality Control has three functions:

Quality Engineering—sets up, with Engineering, points of measurement and devises methods of measurement.

Quality Assurance—provides periodic but non-cyclical auditing of all test and inspection as conducted by Manufacturing to ensure good practices and adequate inspection.

Quality Analysis—assesses the costs of poor quality to motivate Manufacturing to do a better job.

Again and again, engineering executives reiterate that Reliability is primarily an engineering function: "If reliability isn't designed into a product, it cannot be created by production departments." Or again, "Say what you will responsibility for the design cannot be taken from the designer; the Reliability Group can only advise."

Thus there are Reliability Panels to administer and Reliability Coordinating Committees to develop policy, but the Reliability Group does the work, and more often than not, it is in Engineering. And, more often than not, Quality Control has the responsibility for maintaining reliability in Production.

Says one engineer: "Clearly, the product-development group should have the responsibility for resolving questions of reliability and performance specifications as the focal point for the entire company. The proper dividing line is probably at the point of specifications for performance, although in the more complex product areas it may be drawn at the point of process specification. Production of a product to meet these specifications is not a proper engineering function."

One large aircraft company has a production design group attached to the chief designer's

office. This group is concerned with QC and VE as well as producibility. Their first question is always, "How producible is the design?" VA is done by tooling people in Industrial Engineering—an unusual placement.

Several aircraft companies are concerned about the growing multiplicity of R specs—they're trying to find a path through them. Simplification and avoidance of "boiler-plate" terminology are current needs.

Several companies—notably consumer-product ones—have developed an administrative or service engineering section in Engineering. It has responsibility for drafting, records, library, and often testing — and may incorporate whatever specialist functions are provided. Some make a sharp distinction between QC and Statistical QC and Inspection, the former being Engineering-oriented, the latter Manufacturing-oriented or independent.

One engineer comments that products tend to become less technical and more competitive as they mature, and this tends to transfer more responsibility and control from Engineering to Manufacturing. This transfer is a hard pill for Engineering to swallow, but is inevitable and more profitable for the company. He consequently feels that most specialist groups will remain in Manufacturing, Purchasing or their equivalents. He also points out that trainees in Manufacturing tend to be recruited less frequently from available technically trained men.

In contrast, the chief engineers of several heavy-machinery makers feel that the trend to Engineering control is increasingly evident. One goes so far as to say that a truly objective appraisal

VE vs QC

Quality control must go beyond mere inspection. It should help prevent poor quality, not merely weed it out. This is done by watchdogging processes as it watches product through inspection. VE has no function in these areas except when excessive cost involves either.

QC emphasizes **routine** attention to such **quality-influencing factors** as: new designs which may cause excessive rejects, incoming-materials control and product control in conformance with specs, special process studies when they cause rejects, statistics for VE and R on frequency of failure and the like.

VE emphasizes **special** attention to all factors which affect **costs.** QC means primarily **conformance to design,** while VE means **conformance to need.** QC is a **control** function. VE is an **advisory** one.

Value engineering should **not** be limited by the specifications. It should examine specifications just as it questions the design. Big cost reductions start with elimination of unneeded functions or over-demands of too-elaborate specs.

Basically, a QC engineer learns how good quality is compared with how good it should be, and studies what to do about the difference. A VE engineer learns what the part is, what it does, whether something else will do the job, and how the cost and performance of two differing parts compare.

WHY SPECIALIST GROUPS?

The argument for separate organizations for reliability, and for value analysis or value engineering, is well stated by one interviewee in a precision-products plant. He says: "Over-all responsibiilty for reliabilty is a critical control function embodying the cradle-to-grave concept, thereby cutting across the lines of R&D, Design, Contracts, Planning, Manufacturing, Test and Service. Over-all reliability control must be unhampered by organizational alliance and independent of line organizations to achieve objectivity.

"But over-all control responsibility must not detract from one of the major line responsibilities of Engineering achievement of inherently reliable designs during the development and design phases. Responsibility cannot be split, the desired level of inherent reliability must be achieved during design. However, a reliable design must be followed by homogenious manufacture, compatible installation, and prescribed operation and maintenance to attain reliability in the field. Thus a master reliability plan continuously monitored and controlled throughout the life cycle of the product is essential for economical and early product maturity.

"The same thinking applies for a long-range program of value analysis and value engineering. However, getting a VA program started requires concentrated attention sustained over a period of time. In applying VA effectively in design, experience in manufacturing engineering is helpful. But additional engineering talent is needed in applying value engineering to determine system configuration having maximum effectiveness per unit of cost.

"The line engineer is under the burden of inventing on schedule to meet function alone, and will not always have the time and resource to meet VE requirements also."

would combine Engineering and Manufacturing so no responsibility-allocation problem would occur! Another says that they cannot use statistical methods in inspection–still find 100% inspection necessary in building heavy and special machinery.

One good question, often asked, is "Why special groups in the first place?" A good answer is what Leslie Ball (R consultant now with Boeing) has defined as "memory retention"–a centralized gathering and storing place for information, so the company doesn't make the same mistake twice. With high turnover of personnel, this is a very real need.

A LITTLE VA HISTORY

■ Back in the days when value analysis was young (L. D. Miles began it at GE in 1949), there was debate about whether it was an Engineering, Production or Purchasing function. As I understood it, it was essentially a technique for determining whether parts or subassemblies could be made more cheaply some other way or from other materials. It was a post-design (and often a redesign) operation, and for this reason ultimately became a Purchasing function, although performed by engineers.

A few years later, we began to hear of value engineering, basically the same idea, but applied as examination or evaluation by a special team *during design* of the product. VE thus was an engineering function.

The Navy was particularly interested in VA and pushed it strongly during the Korean War and after, but the idea never had so much popularity in industry as it has since the Reliability concept came in. This may, however, be coincidence because, as one value engineer put it: "Reliability is a roadblock to value analysis." He meant, of course, that maximum reliability usually requires the best of every thing, even over-design, while VA seeks to achieve minimum cost, element by element.

The two can, however, have the emphasis and work hand in hand if the objective is maximum value, both to supplier and to user, with minimal maintenance and replacement. As the jokesmiths once put it, "It ain't the first cost, it's the upkeep" that determines real cost or value, so the real conflict is between VA on one side and planned or unplanned obsolescence on the other.

Perhaps an easier way to say this is to bring in the concept of total cost. Total cost is made up of initial cost, installation, operation, maintenance, replacement-parts cost and installation time, availability of replacement, value of lost time—all elements of cost straight through to failure.

Value analysis is a study of each operating function to determine its contribution to the over-all worth of the equipment. Value engineering, as the Navy expresses it: "an objective appraisal of all elements of the design, construction, procurement, installation and maintenance of an equipment, including the applicable equipment specifications, in order to achieve the necessary functions, maintainability and reliability of an equipment at minimum cost (MIL-V-19858 Ships and Bu Ships Instruction 5450.33 Serial 741-861)."

VE compares function and cost

Thus VE is not just cost reduction, it is an analysis of function versus cost. Each characteristic of a design is evaluated to give optimum reliability, and is reviewed to see if modifications can be made that will reduce the cost of providing the required degree of operability and reliability. VE seeks simplification, which produces increased R as a natural byproduct.

SOME VALUE-IMPROVEMENT ACCOMPLISHMENTS

Bureau of Ships, Navy Dept, began its VA program in 1954, since that time has analyzed 2300 projects, of which 1650 were activated. These have saved $35 million, counting savings on each project for only its first year. The program was made necessary by costs rising 500% in 20 years and the shift to much more expensive craft —one nuclear-powered carrier can cost a third of a year's shipbuilding appropriation.

A number of Navy's projects have shown startling savings. These bits and pieces show what can be done:

- Shifting from monel hatch bolts at $5 each to high-tensile steel ones at 10 cents each.
- Redesign of a damper control cut cost from $50 to 60 cents and redesign of insulation fasteners (1.5 million/carrier) saved $100,000 per ship.
- A change in specs on gang-punched walkway plating cut costs from $77,000 to $17,000 on one carrier.
- Air test fittings for compartments were changed from custom at $16 each to standard at 60 cents.
- A standard butterfly valve replaced a custom design to cut cost in half and space and weight four-fifths; annual saving is $750,000.
- Photoengraved aluminum label plates at 14¢ each replaced engraved stainless steel at 27 cents, a saving of $2500 per destroyer or $750,000 a year Navy-wide.

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• Chafing guards for life lines were cut from $3.50 to 25 cents.

• Off-the-shelf running blocks replaced custom ones to save $8000 on two destroyers and $1 million on all ships.

RCA

RCA has a "value improvement program" begun in 1957 which coordinates value analysis in Purchasing, value engineering in Engineering, and methods improvement in Production. They work together in cost reduction and in cost prevention. Cost prevention normally takes place in Engineering by determining the essential function and the simplest way to get it, and through reviewing designs regularly for performance, reliability, maintainability and cost. The "rightness" of a design can change with new materials, processes, field data, and also with the quantity that is being produced.

Each plant function at RCA is given equal responsibility in these six steps:

1. Help everyone concerned appreciate the need.
2. Organize to do the job.
3. Set goals.
4. Develop cost-prevention techniques and train to use them.
5. Develop price-prediction aids as a tool for meeting goals.
6. Continue to improve and use cost reduction techniques.

RCA uses both permanent VA and VE personnel and special teams. VA gets suggestions from vendors on how to cut purchase costs by design changes, and flags suspected high-cost items. VE concern itself with changes in technology that affect design and the like.

Considering all costs of change—including that of the study itself—the cost-reduction program has yielded about 15 times its cost in savings on items designed before cost prevention. **On equipment designed with full cost prevention (VE), returns from cost reduction (VA) are much lower.**

VE can aid R by locating over-designed or under-designed elements, highly stressed components, heat, nonessential refinements, duplicated functions or drafting inconsistencies. Here are examples:

In R & D design of a large radar, high flexibility was attained by using separate inter-bank cable connections. However, it was found that the radar would be housed in a standard building, so integral cabling could be used. Initial costs of $2037 for materials and $3600 for labor were cut to $242 for material and $36 for labor, saving $5359. (Two soldering connections and two mating connectors per wire were eliminated—96 connector pairs per system—considerably increasing reliability.)

In another radar, over-all material costs were cut 11% by a cooperative VA. Here are examples: One selenium rectifier of a new type replaced two old ones to save $53.80, also increasing R by cutting out solder joints and possible human error. A standard potentiometer and gear train replaced a complex special pot to save $44 to $75 cost, gave a smaller, less complex, easier replaced unit of higher R. A knob to control hand rotation of the antenna was changed from a $22 special to a $2.20 standard already stocked by the military, increasing system availability, hence R.

A boresight target assembly was designed with special castings and a rectangular boxbeam. By substituting standard castings and a tube, a VA team cut cost from $3672 to $1412 and improved R by cutting complexity.

Sometimes, specs are unrealistic. In one instance, VA suggested cutting a "no flicker" spec to "no flicker 99.5% of the time." This slight reduction cut cost from $12,000 to $7000 with no appreciable loss in R.

New Holland

New Holland Machine Co established a VA program in 1954, broadened it to include VE in

RELIABILITY AND VE

Reliability, as we said a year ago, has various definitions, depending upon plant and industry. Basically, however, it is the probability that a product will perform satisfactorily a specified function under given conditions for a specified period of time. Thus it incorporates a probability, function, environment and time. It can be enhanced by many efforts, including:

1. . Simplification.
2. . Reduction of the number of parts.
3. . Use of supporting or secondary circuits or devices ("redundancy").
4. . Addition of standby.
5. . Marginal checkout techniques.
6. . Modularization, easy location of test or maintenance points.
7. . Increased component life.
8. . Improved use of components.
9. . Standardizations.
10. . Environmental controls.
11. . Feedback of service and test data.
12. . Skilled and preventive maintenance.

Each of these involves costs; some decrease cost automatically, others increase them initially, so added value must be equated to cost as well as Reliability (R). There is also a direct tie-in between R and Value Engineering (VE) in many of these items, notably 1, 2, 5, and 9.

These similarities, as well as practical considerations, suggest an educational program in R and VE for all designers including advance information on pitfalls to be avoided. In no case, should either R or VE programs take the responsibility from the designer; they are merely advisory.

1956. The Value Engineering Group is in Purchasing, but undertakes projects for everyone on request. Included in projects: Over-design in a gearbox cover was detected through a study on the high cost of dowel pins used in it. A power takeoff was similarly over-designed. A household window fastener replaced a bolt and wingnut for removable panels, cutting costs and simplifying design and maintenance. In a critical spring, lower-cost material, pre-set, saved costs. Redesign to eliminate an external grease line and fittings saved $1700, cold-formed parts on a disk assembly saved $5000.

Hughes

Hughes Aircraft saved $21-million in a typical year through a program stressing:

1. Conserve materials, equipment, time, energy.
2. Improve methods, facilities, product quality.
3. Simplify operations, product.
4. Substitute lower-cost materials.
5. Eliminate waste, error, hazards.

Recently, value engineering has been added to the program. VE at Hughes differs from straightforward cost improvement which is an extra-curricular program for everybody, while VE is a concentrated effort by specially trained, value-oriented personnel on a full-time basis. They appraise a system or a product to attain performance, reliability and maintainability at lowest cost. Through VE, one division saved $2.4 million in one year, Engineering attained 126% of its half-year cost-improvement bogey, with 54% attributable directly to VE.

VA vs QUALITY

Value analysis can easily be downgraded into cost reduction only, and that in turn corrupted into *quality* reduction. Many designs are initially too elaborate and too costly, and the alert analyst can find and remove these elements—material, process, or component—without affecting the value of the product to the user. But the temptation is everpresent to shade quality or make a price (or both). What the engineer must do always is to approach analyst suggestions (or his own design) with an open mind, asking such questions as these:

1. What parts of this unit were designed on the basis of custom or habit, rather than on function or need?
2. Is this part really necessary?
3. How versatile must the product *really* be?
4. Will a change of process reduce the material quality or gage required? Can beading, contouring or ridging, for example, replace mere weight to give needed rigidity?
5. Is my special component really only a "Chinese copy" of a standard component costing less?

TEN QUESTIONS

RCA has these 10 questions as tests for a design. Have you:

1 . . Challenged specification requirements?
2 . . Eliminated unnecessary parts or functions?
3 . . Simplified the design as much as possible?
4 . . Made maximum use of standard items?
5 . . Used least-costly materials?
6 . . Designed for lowest mfg cost?
7 . . Relaxed tolerances as much as possible?
8 . . Used lowest-cost finishes?
9 . . Used company Materials & Component Specialists?
10 . . Fully utilized Purchasing's assistance to gain supplier's "know-how?"

Obviously, items 1, 2, 3 and 4 are sound Reliability procedures too. But 5, 6, 7 and 8 may be working against R and must be equated with it if both R and VE are important.

A lever latch for a Falcon shipping container cost $17 and four were required. Substitution of a small quarter-turn latch raised requirements to eight per container, but cost was cut to 30 cents each. Net saving per container was $62.40, or $61,152 per year. When a standard bolt was substituted for a special to secure a box of etched circuit cards and simplify design, cost was cut from $1.50 to 30 cents. A synthesizer chassis was shifted from a casting to a dip-brazed sheetmetal assembly. Tolerances difficult to maintain in the casting were attained and cost cut 78%.

Boeing

Patterned after GE's orginal value-analysis system, that at Boeing Aero-Space is only three years old. It differs from the GE plan, however, in that it is directly under Management (as is the Reliability Group), rather than under Purchasing. There has been some feeling there that the limited-production character of Aero-Space operations, as contrasted to typical GE quantity production, might well put the VA Group in Engineering—operating as a value-*engineering* group. However, on such a problem as the Dyna-Soar missile, the emphasis must be on *quality* rather than *cost* during development. It embodies several avant-garde ideas, one being particularly interesting because it turns the clock back to the structural practice on earliest planes—a core structure to carry load, with the skin carrying no stress, but just involved with heat.

The present VA Group is not engineer-oriented; it includes specialists in packaging, fabrication and electronics. Experience thus far has been that the value analyst who is not an engineer does not anticipate, or is not stopped by, engineering problems, thus provides a good contrast. Problems

V

thus far have included locating a source for René 41 forgings and for special seamless tubing.

Among VA savings at Boeing are these: Redesign of a dado strip for the 707 that cut material and handling as well as fabrication costs 84% . . . Replacement of a special thermal-relief valve by an off-the shelf unit, saving 76% . . . Almost $100,000 were saved by working out a procedure for reuse of Bomarc dust caps and plugs . . . Redesign of a missile battery so only cells and rubber components are discarded each six months, saving annual costs of $700,000 . . . Change from a weldment to a casting on antenna coupler assemblies saved 62% . . . Reducing excess grip-length on pieces to be stretchformed saved $56,000 per year . . . A stump-type Ti fastener replacing a pull-up type on one section of the B-52 saved $100,000 . . . A corrosion-resistant steel washer replaced a stainless one on the Minuteman, cutting cost from $1.51 to $0.005 each—a 99.8% saving.

ABMA

Brig Gen Richard M. Hurst, commander of the Army Ballistic Missile Agency, Huntsville, Ala, said recently that he hoped, through VA, to increase by 25% the number of missiles produced. He feels more effective communications are major answers in achieving economy, just as they are in achieving reliability.

HOW ARE SPECIALIST GROUPS ORGANIZED?

■ In coordinating reliability, quality control, value engineering and other special functions, how do you set them up? This is the third question in our survey, and the least important in the opinion of engineers who have been through the experience of setting up such groups. **They point out that the first problem is to establish and agree that these functions have merit, can be used, and will result in gain for the organization.** The concept is the same for every organization, regardless of size, complexity or product. How important is quality or integrity compared with price? What is management's attitude?

Next comes the function. This may differ because of product, personnel, quantity to be produced, and like factors. A simple, traditional product, on which design is changed infrequently, suggests emphasis on VA and QC; a complex, limited-production, costly item shifts emphasis to Reliability and VE. Is the function to monitor, to advise, to audit, to control? Which factors are to dominate if trade-offs are necessary? What authority will be granted the group?

Finally, the organization itself, which differs widely from plant to plant, even from division to division or department to department within a company, just as Engineering itself does. It varies with product, with quantity, with complexity, with manufacturing method, and particularly with personnel. And it will vary markedly with management's definition of the function being discussed.

A Quality Control Group will not do the same work in every company; reliability does not mean the same thing in any two plants. Even the semantics are a problem; there are no standard definitions. One large company spent three days of conference time to arrive at acceptable definitions of basic terms. These are shown here (page 84)—and will be challenged immediately by everyone.

But there are certain broad areas of agreement. Most engineers agree that value analysis is part of Purchasing, that quality control is Manufacturing-oriented. But some companies have Reliability Groups or Quality Control Groups reporting to general management, some have QC reporting to the head of Engineering and monitoring production, and so on.

Where Reliability fits in

While VE and R are generally engineering-oriented, there are exceptions. One maker of missile components has the R group as part of Quality Control, so the emphasis is on production and testing (quality assurance) rather than on design. The group conducts a tight receiving inspection and makes sampling tests of incoming items, obtains and analyzes failure data and test information from facilities and subcontractors, but has virtually no contact with Engineering. Incidentally, its submergence in Quality Control has led to a high turnover of men as they attain competence.

Several companies combine Reliability with Standards, an apparently sound combination. In one large setup, such a group acts in a checking and advisory capacity, while actual R testing on new products is done by a product-testing laboratory. This well- equipped group is independent of Engineering, monitors all new designs in the breadboard or prototype stage.

To an increasing extent, Reliability Groups are in Engineering and report to the chief engineer. The parallel function of acquiring data in procurement and manufacturing is performed by Quality Control. Failure reports feed R data to QC and other groups. This is in line with the Navy approach, although the Air Force prefers (AF 375-5) to have R report at the top—to division or general manager.

Quality vs Reliability

Reliability and quality are being linked increas-

ingly in industry, with each word having a special meaning. Reliability is the newer concept covering the probability that the product will perform satisfactorily a specified function under given conditions for a specified period of time. Quality is perhaps more properly "quality assurance"—the integration of all functions to achieve a product that meets all requirements—thus somewhat parallel to reliability. This "quality" covers the analytical and preventive aspects of quality control, as well as quality control itself.

In a major missile producer, R is given top priority, the Group reporting to the general manager. Data from Engineering, QC and Product Support (field engineering) are combined in the Reliability Group. Mathematical data from Engineering are monitored there, and close liaison is maintained by R men assigned to Engrg and QC.

Reliability is still basically a "dependability" program in non-defense industry, with data and techniques being added to give mean-life-to-failure data and the like. A typical setup places test or prototype units in the hands of selected customers at the same time the company does its own testing. Statistics from both groups can be transferred to punch cards and data collated for study by a product-improvement committee.

Experience in one plant during the past three years indicates that infant mortality occurs within 25 hr, and that 100 hr of use in test or in customers' hands corresponds to about three months of service use. In regular production, four of each 100 units produced are tested; one failure stops shipments until the difficulty is corrected. This company, incidentally, makes styling changes only when tools or dies wear out—usually 1½ to 2 years.

THE COST OF RELIABILITY

"It isn't reliability that costs money, but unreliability." This slogan has been prominently displayed by some companies, supported by evidence that the less-reliable product requires larger inventories of spare parts, increased maintenance and costly repairs. It is of course obvious in the case of non-maintainable assemblies like missiles, rockets and satellites, almost as true in the case of critical products like airplanes, safety devices, warning devices—even automobiles—where failure may result in total loss accompanied by loss of life. But it is none the less true in products where the results of unreliability are less evident.

Reliability often also increases the cost of engineering design—something that chief engineers are guarding against these days. But the over-all result may be a saving as a result of lower costs in testing. Similarly the apparent conflict between reliability and value analysis may not exist in actuality because the simplification of design that results from value analysis usually also increases reliability.

The Minuteman missile, for example, offers no greater performance than its predecessors. Its major advance is in reliability—to two orders of magnitude. Reliability in missiles is characterized by one R head as "nit-picking meticulousness", which must involve itself even with the infrequently occurring causes of failure, to maintain a reliability that cannot be measured. The real question is whether the popular "permissive management" system is good enough; at least one missile maker has gone back to authoritarian methods, because the only controllable factor in missile production actually is labor.

A curious offshoot of current emphasis on reliability occurs in connection with fuel cells. Battery reliability is extremely high—one failure in 100,000 is considered unusual and almost disastrous. The fuel cell and other new power sources must approximate that reliability before they can go very far.

HOW TO SET UP VALUE ENGINEERING

Before there can be a VE unit, management must understand what the VE unit can do and be willing to support it to the hilt. This means that management must be willing to admit that unnecessary costs can exist, and why they are there. Management must have a "constructive discontent."

VE is *not* purely a "big-company" operation; it can be handled by one competent man if necessary, or even by a part-time consultant, if the atmosphere is right and proper indoctrination is provided for decision-making people. It can also be applied regardless of product quantity or complexity because it is essentially a review or advisory operation, asking the questions about the trees when the designer and production man are preoccupied with the forest.

If we accept the increasingly common designation of value analysis as cost reduction, value engineering as cost prevention, there must be two operations: VA in Purchasing, and VE in Engineering. Or an over-all department or group can be set up.

Where does VE report?

Of 20 companies polled by Electronic Industries Assn, VE reported to Manufacturing in three, Manufacturing Engrg in four, Engineering in five, Purchasing in five, top management in two and Industrial Engineering in one. There is no single "best location"—it will vary somewhat with personnel and organization of a particular company and with the ability or bent of the man who heads it up.

Experienced value engineers are hard to find; the idea is still relatively new and has been growing slowly. The successful man must get along

with line executives, yet retain his ability to pry into problems. In a way he must be an anomaly —a well-rounded experienced man with an active curiosity.

The value engineer's job

He should be able to set up and operate training programs, lead and operate cost-reduction committees, act as value specialist in design reviews, handle depth studies on product evaluation, direct and train special task groups, and suggest basic cost-control efforts. Above all, he must not be given other responsibilities "part time" or the whole effort will collapse.

Given a man, goals must be established—usually in terms of ratio of cost to return. A good VE department should return from 10 to 20 times its cost. (The Navy started in 1954 with 10:1, is now at 16:1.) It must of course start slowly and be content with less initially—working with simple parts and simple problems until the skills of its members and outsiders working with it mature. Unless skills and interest are built up outside the group; unless the cooperation of the line organization is built up, the effort is almost certain to fail.

Obviously, proper facilities must be provided and the relative authority and responsibility of the group must be clearly defined. It must have access to data and records so its effects can be shown.

Some companies have simply designated men from their own staffs as "value engineers," and in effect use them only when they have a competitive problem. This achieves some results, but is by no means as effective as constant attention to VE by a man or men trained to look for savings. **It is important that someone (preferably trained) be given long-term responsibility for cost savings, with no other assignment to split his loyalties or interest.**

Training of value specialists is an essential step toward maintenance of a program, far better than the pirating that has been practiced. Specialized training is of the workshop type ranging from 40 to 120 hr. Most training plans use vendor specialists, and have teams from all departments evaluate proposals developed in training.

Sources of information

Programs can be conducted by outsiders within a plant or for a local group. Among organizations doing such work are Value Analysis Inc; Industrial Education Institute; University of California. Northeastern University is developing a program, as is Electronic Industries Assn.

Training courses must be followed by periodic refreshers. GE, for example, follows basic training by six months of experience, then a refresher, another six months of work, and another refresher.

Papers of the VE Symposium of the EIA in 1959 are available from Engrg Publishers, Box 2, Elizabeth 2, NJ, at $6 per hard-backed copy. Papers of the 1960 symposium will be available soon at $7.50. Industrial Education Institute has a VE and VA Reference Manual at $15, Industry Reports Inc, 1327 F St, Washington 4, DC, has Value Engineering Weekly at $75/year. L. D. Miles has written a book on the subject, to be published by McGraw-Hill in August.

WHAT'S "PRODUCT ASSURANCE"?

As product complexity has grown, retained engineering experience has declined with personnel turnover, shortage of engineers, and other factors. Consequently, design time has increased, while time to product obsolescence has decreased. Within adequate development, the design may become obsolete before it has matured. Thus the traditional method of basing final design on user data is now too slow.

This situation has given rise to the new function known as product or quality assurance, which combines performance, reliability and economy. This is often handled by a separate group, collecting data from design, production and the user, evaluating it and feeding it back to Engineering. Essentially, Product Assurance combines reliability and value analysis.

Activities of a Product Assurance Group encompass:

1. Collection and evaluation of performance, cost and reliability data.
2. Development of assurance tools—component and system indices, economy techniques, design-effort allocation, publications, reliability techniques, and a regular report.
3. Education and consultation—regular seminars are held for all engineering departments.
4. Design review—check user needs, system and component design, test and operating results, as design develops.

SLOGANRY

While there are violent objections to any such term as "idiotproof"—and sincere belief that no designer should be responsible for incompetent operation of his products, the expressions concerned with this element continue to grow. Some current ones:

- **Make the design GI-proof**
- **A design can be made foolproof, but not damfool proof.**

One company has developed this 4-step formula for reliability, called the "DMUF system:"

- ***Design* it to be reliable**
- ***Make* it like the design**
- ***Use* it as intended**
- ***Feed back* the results**

Some wag promptly dubbed this the "Damn Mess Unless Followed" system.

5. Test design and criteria–statistical techniques for determining minimum time and cost for tests by purchaser, design, and production.

6. Automatic model updating–collect and disseminate to Engineering information on design changes and how well model is meeting the design objectives.

7. Industry participation–exchange information and research literature and meeting reports.

Most useful of the PA Group's activities is the Product Assurance Report, basically a tool to locate components most deserving of extra effort and to demonstrate attainment of results in dollar savings. It can also be used by management to monitor progress or slippage in competitive position, vendor selection, cost reduction, reliability and added value.

Each system or major component is listed and data recorded for time period, quantity, number of failures, life in hours, and the prevention, down and rerun percentages of time under load. Cost of failure in product performance can be computed for equipment, maintenance and user losses from equipment failure.

IS PRODUCTION LOSING ITS GRIP?

■ In the light of the long-term trend toward specification and control by Engineering (or Production Engineering) of such elements of operation as heats, heat-treats, solutions, feeds and speeds, method of manufacture and many other elements of processing, there seems to be a shift toward relieving Production of many of its responsibilities. In our interviews we suggested, therefore, that there might be a shift toward a three-section Engineering setup: (1) R & D or Advanced Design, (2) Product Engineering, (3) Testing, Value Engineering, Reliability and similar services. We further suggested that the first two sections might handle new and redesigned products straight through into production, leaving the Production Dept as primarily a labor-handling setup.

This generated much comment—for the most part that this would not happen. The general feeling was that Engineering and Production would remain separate, with present functions. Reliability, Value Engineering, and like groups will be in Engineering; quality control, production test, material supply, shipping, inventory, safety and like functions will remain in Production.

However, there are these two trends: (1) Addition of, or strengthening of, control groups reporting to top management to monitor and audit over-all effectiveness of production in adequately meeting customer requirements at minimum cost. (2) Increase in technical capability of the line organization for more scientific approach to production processes with increased use of machine programming, computers and analysis.

Here are typical opinions:

• "It depends on product, conditions and personnel, but, generally speaking, the technical functions should be in one department so the buck cannot be passed. Put all functions of manufacturing in Manufacturing; all design, performance and reliability in Engineering. Then make sure the two departments work together."

• "Product Engineering should report to the plant manager with Manufacturing, Assembly, Quality Control and the like. Closer association is necessary between Engineering and Manufacturing, with one senior vice-president in charge of the two functions."

• "We have noted a swing back to real manufacturing management in the last year."

• "Too many functions dilute the effectiveness of Engineering. Manufacturing needs to develop its own creative approach to processes, plant layout and materials handling and must move forward in step with development and product-design activities rather than resigning such future higher orders of capability to the development groups. This is necessary if the R & D and Product Design groups are to be kept free . . ."

"A production design group in Engineering Research can organize project designs for production, but should not take on tool engineering even though its members know how any part will probably be manufactured. Quality Control is growing in effectiveness so rapidly that it can be used in Research, Engineering and Manufacturing."

• "Product Engineering at the plant level should report to the plant manager with Assembly, Quality Control and similar services. This will need a better association between Manufacturing and Engineering."

• "Engineers should devote themselves to technical work and let others operate after things are spelled out. Also the motivations necessary to produce economy carefully and to schedule are different from design motivations. Product Engineering and Tool Engineering must be coordinated to get new models out on time, but this has been accomplished by liaison rather than by placing Tool Engineering in Product Engineering. Tool Engineering is a function of Manufacturing rather than of Product Development."

• "Product Engineering and Tool Engineering may or may not be a portion of the development responsibility, depending upon the plant environment. The principal function of production is to make a product according to schedule and costs, and add improvements that do not affect performance. Production is essentially a labor setup and management organization."

• "Product design, tool engineering and produc-

tion engineering must be coordinated very carefully, but we do not expect control of one by the other."

• "Inspection responsibility has been largely taken from Production in recent years, and given independent status, reporting directly to management rather than to Engineering. Thus it has full responsibility for quality. The trend in the automobile industry is to separate Reliability and Quality Control functions."

• "We have kept tool design, process control, inspection and statistical quality control in Manufacturing, but have cost reduction, value analysis, quality control and reliability under the Product Improvement section of Engineering. Test facilities are individually controlled by the groups that need them, and are geographically separated."

• "We need engineers trained both in product engineering and production engineering—then we could have a single engineering management." (This is one of the few dissenters.)

A longer aircraft analysis

• "While our situation may not hold in general industry, the following pattern is common within the airframe, missile, space, and electronics industry. Advanced design groups generally work with operation analysis and concepts. Preliminary design groups reduce a concept to a product with specifications for performance and evaluate aerodynamic and dynamic characteristics. Testing usually is a staff engineering function concerned with initial qualification and environmental testing of various types on components and elements of the design; it does not include production testing performed by Quality Control.

"Value Engineering, which includes Value Analysis and Reliability, is usually a staff engineering function reporting to a relatively high level of engineering management. Production Engineering is usually a Product Engineering function and reports to engineering management; it includes certain phases of value engineering such as evaluating design for ease of manufacture, low maintenance, cost and standard components. The tooling function consists of preplanning, tool planning, tool design, and tool making, usually reporting to Manufacturing rather than Engineering. The pre-planning in tooling and production engineering work closely to make the design producible.

"In the missile and space field, much of this work is done under engineering management; however, quality control is usually a general management function."

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Westinghouse Electric Corp, Pittsburgh—J A Hutcheson, vice-president

Whirlpool Corp, St Joseph—Wm E Mahaffay, vice-president

Want a plastic, but need a metal? Take a . . .

CLOSER LOOK AT FIBERGLASS-REINFORCED THERMOPLASTICS

W H CHADBOURNE, *president*
Fiberfil Inc, Warsaw, Ind

For mechanical parts that must carry high loads, the "performance gap" between thermoplastics and metals is still very real. But the gap is beginning to close, thanks to the addition of glass fibers. As with the thermosets, the technique creates entirely new materials.

Despite their five outstanding advantages—low unit cost, lightness, resilience, natural lubricity, and chemical stability—the thermoplastics have four serious shortcomings as load-bearing materials in mechanical components. These weaknesses are high thermal growth, cold flow under load, dimensional instability because of moisture absorption, and generally low mechanical properties.

There are two ways to surmount these problems: The first—improvements in existing polymers or introduction of new ones by the polymer producers—is being well explored and has shown significant results in recent years (*PE—Sep 29 '58, p 36*). The second method—mechanically reinforcing existing thermoplastics—is less familiar, despite designers' familiarity with reinforced thermosetting resins (*PE—Jan 11 '60, p 47*).

The accompanying table shows what happens when glass

TYPICAL PROPERTIES OF THERMOPLASTICS—UNREINFORCED VS REINFORCED
(3 die-casting alloys included for comparison)

PROPERTY \ MATERIAL	POLYAMIDE (Nylon 66)		POLYSTYRENE[1]		POLYCARBONATE		STYRENE-ACRYLONITRILE[2]		ZINC	ALUMINUM	MAGNESIUM
	Unfilled	Filled	Unfilled	Filled	Unfilled	Filled	Unfilled	Filled	(AG 40A)	(No. 380)	(AZ 91B)
Tensile strength, psi x 1000	11.8	19.1	6.5	14.0	9.0	19.0	11.0	20.0	41.0	43.0	33.0
Notched impact strength, ft-lb/in.											
at 73 F (½ x ½ in. bar)	0.9	2.5	0.3	3.2	2.0[3]	4.0	0.45	3.5			
at −40 F (½ x ½ in. bar)	0.6	3.0	——	2.9	1.5	4.0	——	4.5			
Tensile modulus, psi x 10^5	4.0	8.6	4.0	11.0	3.2	8.8	5.2	15.0	(creeps)	103.0	65.0
Elongation, %	60.0	1.5	2.0	1.1	60–100	1.7	3.2	1.4	10.0	2.0	3.0
Deformation under load (4000 psi), %	2.5	0.6	1.6	0.5	0.3	0.1	——	0.3			
Heat-distortion point (264 psi), °F	150	498	183	220	280	300	200	220			
Thermal-expansion coeff, in./in./°F x 10^{-5}	5.5	1.71	4.0	2.2	3.9	0.7	4.0	1.0	1.45	1.16	1.43
Water absorption (24 hr), %	1.5	0.7	0.03	0.07	0.35	0.09	0.23	0.15			
Flexure strength, psi x 1000	11.5	22.0	11.0	17.5	26.0	12.0	17.0	28.0			
Compressive strength, psi x 1000	4.9[4]	16.1	14.0	17.0	19.0	11.0	17.0	22.0			
Hardness, Rockwell	M79	M100	M70	M95	M70	M95	M83	E68			
Specific gravity	1.14	1.36	1.05	1.28	1.2	1.45	1.07	1.35	6.6	2.7	1.81
Approximate cost, cents/cu in	4.0	7.2	0.7	2.5	5.6	9.4	1.5	3.8	3.4	2.3	2.0
Dielectric strength (short time), v/mil	385	500	500	396	400	482	450	——			
Volume resistivity, ohm-cm x 10^{15}	450	5.5	100	36.0	20.0	1.4	10.0	——			
Dielectric constant (60 cycles)	4.1	4.0	2.6	3.1	3.17	3.8	3.0	——			
Power factor (60 cycles)	0.0140	0.0180	0.0030	0.0048	0.0009	0.0030	0.0085	——			

[1] Medium-flow, general-purpose grade; [2] Heat-resistant grade; [3] Impact values for this resin are a function of thickness; [4] Value at 1% deformation.

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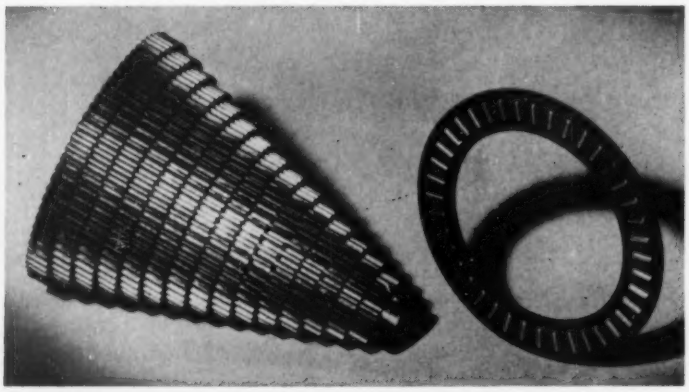
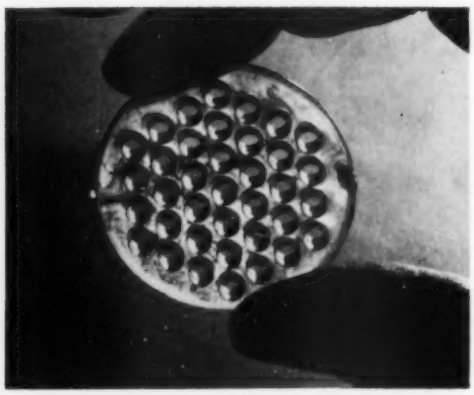
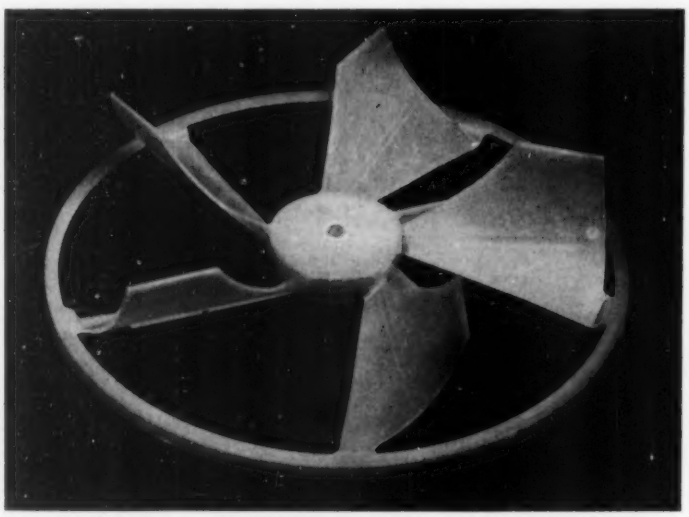
4 REINFORCED THERMOPLASTICS MAKE THESE PARTS SUCCESSFUL



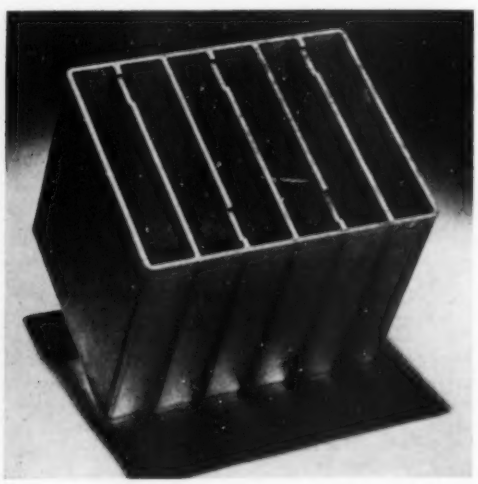
POLYAMIDE STEP-GEAR AND THRUST BEARING RETAINER are filled with glass fibers to cut dimension change caused by local heating: step-gear is from a computer train containing 39 gears running at high speed without external lubrication near warm electronic components; auto thrust bearing operates in steering system, shift mechanism and transmission without lubrication. Molydisulfide filler adds to natural lubricity of nylon.



POLYCARBONATE FACEPLATE for multiple-pole electrical connector meets military requirements for self-extinguishing dielectric material, while fiberglass filler minimizes dimension change caused by moisture absorption and temperature change. Holes retain spacing and shape after repeated coupling and uncoupling.



POLYSTYRENE BLOWER WHEEL for air conditioner is molded from reinforced resin to reduce blade deflection at high rpm. Angle-shaped rim runs through catch-basin to remove cooling-coil condensate; should this condensate freeze, stiffness and impact resistance of the reinforced wheel will now sustain resulting shock.



STYRENE-ACRYLONITRILE BATTERY CASE for an ICBM must resist chemical attack and rapid heating caused by sudden injection of battery chemicals at launching. Glass filler gives added strength and stiffness needed to sustain high g-loadings.

reinforcing fibers are added to four common thermoplastics —nylon 66, polystyrene, polycarbonate and styrene-acrylonitrile. A few pertinent properties of three common die-casting alloys are shown for comparison. Examination of the first eight properties—the key ones in most applications—shows that glass reinforcement "improves" properties in comparison with the unfilled polymers and brings them significantly closer to die-cast metals in many respects. The improvements include the following:

• **Tensile strength** of all polymers nearly doubles when reinforcement is added. Metals are still far stronger, although there are special high-glass-content grades of reinforced nylon (not shown here) that have tensile strengths up to 30,000 psi.

• **Deformation under load** for thermoplastics is normally taken at 2000 psi (and at 122 F), but at this stress level the reinforced materials show only slight deformation. Stress for this test was therefore increased to 4000 psi.

• **Notched impact strength** of filled materials goes up as temperature drops; for unfilled resins strength goes down. Of course, die-cast metals will resist impact better than plastics, filled or unfilled, at both room and low temperatures. However, impact tests performed on metals and on plastics do not correlate well, so that values for the metals are not included.

• **Resistance to dimensional change** in operation is improved by reinforcement, since moisture absorption is reduced to ¼ to ½ of previous levels and since the thermal expansion is cut to ⅓ to 1/7 of that for unfilled materials. (Metals, with relatively low thermal-expansion coefficients, still hold the dimensional stability advantage, however.) Filling a thermoplastic also makes it change dimensions less under the influence of relaxing internal strains.

MATERIALS AVAILABLE

The four polymers listed in the table were chosen because their characteristics span the wide variety of requirements for mechanical parts, and because all properties improve by at least 50% (100% in tensile strength) when these resins are reinforced. Polyethylene, polypropylene, and acetal resins can also be reinforced, but their property profiles do not improve across-the-board in this manner. Reinforced fluorcarbon resins are also available, but are not generally considered "structural" thermoplastics in the sense of this article—even though special fiber-orienting methods will give tensiles as high as 7500 psi (*PE*—Mar 20 '61, p 76).

Polyamide resin, as the most familiar and versatile of the structural thermoplastics, has the greatest number of filled grades. Besides filled materials based on nylon types 66, 610 and 6, special compounds can be made, including: a better-flowing grade for difficult moldings, a hydrolysis-resistant grade for hot-water applications, a grade containing MoS_2 for added lubricity, a heat-stabilized type, and three high-glass types with strengths equal to thermosetting molding resins.

Polystyrene has the prime advantage of low cost, but is not generally considered suitable for high-strength mechanical applications. Adding glass adds enough strength, stiffness, dimensional stability and impact resistance at low temperatures to make the resin suitable for many high-load applications. Two recent examples that illustrate this upgrading are: a one-piece crashpad insert for one of this year's cars, an injection molding about 5 ft long; computer tape reels that resist high centrifugal forces and braking-loads near warm electronic gear.

Styrene-acrylonitrile gains solvent resistance over polystyrene through copolymerization with acrylonitrile. Reinforcing this resin with glass not only adds strength, but overcomes long-term stress cracking that often plagues the unfilled resin. Cost is between that of filled styrene and polycarbonates.

Polycarbonate is rapidly being accepted as a high-performance mechanical material, particularly in hot, humid environments or where the self-extinguishing flammability characteristic is a must (*PE*—May 1 '60, p 46). Reinforcing with glass cuts polycarbonate's thermal-expansion coefficient sharply and stabilizes electrical properties over a wide frequency range, in addition to increasing strength and stiffness. Filled polycarbonates are newest of the reinforced thermoplastics.

DESIGN CONSIDERATIONS

Draft should be increased slightly because of low elongation and low mold shrinkage, compared to unfilled materials. A good rule is 0.02-in. draft per inch of depth. Undercuts are not recommended for the same reasons, although a part with an undercut can be ejected from the mold in a slightly flexible "green" state if necessary.

Fabrication is by normal injection molding; extrusion grades are under development. Compression molding does not generate sufficient pressure and velocity to disperse and knit the reinforcing fibers enough to give best properties. Parts molded in cavities designed for unfilled resins will be oversize, as mold shrinkage is 50 to 60% lower. Thin sections fill readily and walls as low as 0.010 in. can be specified.

Prototype parts should be produced in single-cavity molds, where possible, rather than machined from reinforced rod or bar stock. This is because extensive machining cuts through enough reinforcing filaments to greatly reduce strength and other properties. Results of tests on such parts are best characterized as "instant disaster." For minor secondary-finishing operations, such as drilling or lathe work, use carbide-tipped tools. Wet-grinding of close-tolerance cams is readily accomplished.

Cost of reinforced thermoplastic compounds runs from 50 to 100% more per pound than their equivalent unfilled resins. They tend to be cheaper than aluminum, brass, bronze, magnesium and zinc, particularly if the metal part requires secondary finishing. Filled thermoplastics are not "price" materials; rather, they are chosen because of design and performance advantages.

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EDITOR'S NOTE: For other recent articles on plastics that have been reinforced to extend their performance:

Filled TFE Teflon + Moly Disulfide, Mar 13 '61, p 76—Oriented glass fibers make Teflon strong, while the solid lubricant keeps it slippery.

Designing High-impact Phenolic Molded Parts, Mar 7 '60, p 54—Adding glass-fiber reinforcement can make conventional phenolics a strong competitor to metals where shock loads are a problem. Article gives proper design criteria to use.

Polyester Premix Molded Parts, Oct 12 '60, p 76—They can be substituted advantageously for metal in many applications, but design must follow different ground rules than for unreinforced plastics.

What Fillers Will Do for the Latest Teflon, Sep 28 '59, p 52—Like the older fluorocarbon resins, the copolymer type called Teflon 100X works better in some applications when it's reinforced. Article gives recent design data on this newest fluorocarbon in filled form.

Additives Strengthen Sintered Nylon, Sep 15 '58, p 86—Article shows how sintered nylon parts are made; cites materials available, tolerances possible; gives the right design approach.

—Ford Park

the new developments in BEARING and GEAR LUBRICATION

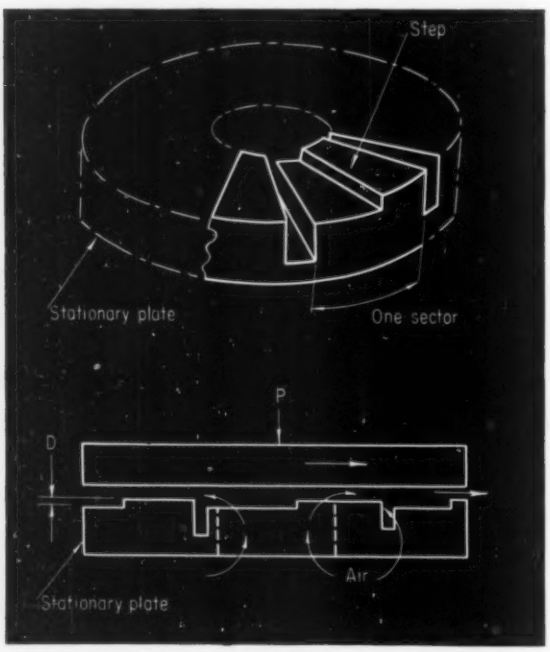
A wealth of new equations, design charts and performance data enriched this year's ASLE meeting in Philadelphia. Here's an on-the-spot evaluation of key developments.

NICHOLAS P CHIRONIS, *associate editor*

There was a good crop both of new concepts and down-to-earth design information at this year's ASLE annual meeting. Experimental programs are moving forward rapidly in the fields of lubrication and wear, and most of the researchers have translated the data into useful equations and charts for bearing and gear applications. Key developments covered air, sleeve and rolling-contact bearings, improved lubricants' and lubrication techniques, wear data, gear lubrication, and new testing methods. These developments are reported below. Numbers in parentheses refer to papers; copies are obtainable from the American Society of Lubrication Engineers, 84 Randolph St, Chicago, at 75¢ each (50¢ for ASLE members).

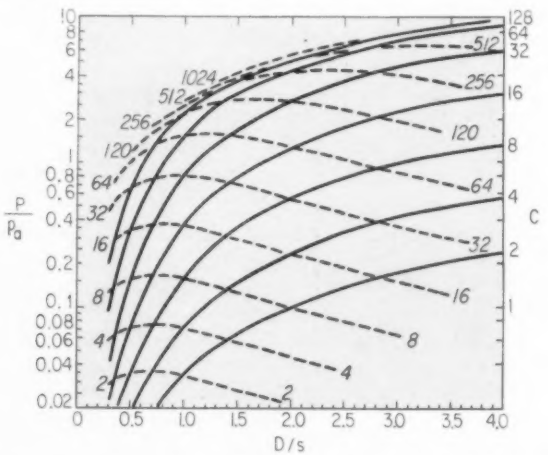
Stepped air-bearing design chart

One of the best configurations devised for air or gas bearings is the stepped-sector thrust type. It is a self-actuated (hydrodynamic) type in that its rotation alone is



sufficient to pull in load-bearing air between the two thrust plates, avoiding need for externally pressurized air. It is a good performer—properly designed, it can easily support a load of 30 psi of thrust-plate area—and its simple configuration is easily machined. But past attempts have not developed a sufficiently practical set of formulas for predicting its performance. The method presented at the meeting (61 AM 5B-1) by the noted theoretical engineer, J. S. Ausman, may well overcome this difficulty.

Ausman, formerly of Autonetics and now with Litton Systems in Woodland Hill, Calif, developed an approximate, but still highly involved, mathematical solution. This was checked against previously known test results and then fed into a computer to develop the practical design curves shown below.



The stationary plate of the bearing is divided into sectors or pads, each having a minute step, generally no deeper than 0.0001 in. to 0.0003 in. The deep grooves between the sectors, and the hole in the center, permit the inflow of air. Ausman also computed the optimum number of pads, ranging in most applications from 5 to 10. For the design chart: C = compressibility number = $6\mu\omega R^2/p_a s^2$, μ = viscosity of air or gas, ω = angular velocity, R = outer radius, p_a = ambient pressure (usually 14.7 psi), P = bearing-load pressure, D = step depth, s = minimum clearance (selected by the designer—a large clearance reduces load capacity but avoids unexpected metal-to-metal contract).

The solid lines are for cases where the step-depth is kept constant; the dashed lines, where the minimum clearance is kept constant. By assuming a step depth and minimum clearance, C can be computed, and the load capacity P/p_a picked off the chart. Or, starting with P/p_a will give the optimum dimensions of the step bearing.

The self-actuated type of air bearing should be lightly loaded during start of operation. This is no problem when

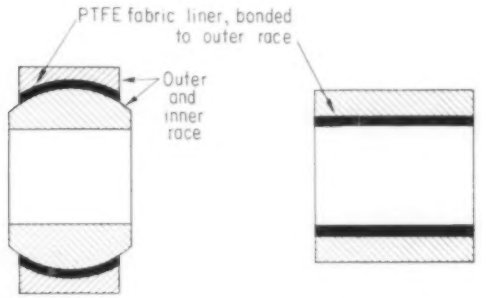
combined with journal bearings such as in turbines where thrust loads do not develop until speed builds up.

Fabric-lined bearings for high loads and temperatures

Several experimenters from the aircraft industry are enthusiastic about the capabilities of metal bearings lined with PTFE (polytetraflouroethylene) resin. W. D. Craig Jr of Grumman Aircraft (61 AM 6B-2) found that PTFE-lined bearings can take high bearing loads and slow-speed oscillation without lubrication; F. J. Williams of North American Aviation (61 AM 6B-3) found that the addition of a fiber-cloth backing permitted these bearings to operate up to 550 F, also without lubrication.

Craig's investigation of spherical and sleeve-lined bearings (see sketch) showed that:

- PTFE unlubricated sleeve bearings permit loads ranging from 25,000 to 32,000 psi, as against 15,000 to 20,000 psi for aluminum-bronze bearings lubricated with grease.



This allowed smaller shafts and pushrods and saved 33 lb in one aircraft control system.

- Initial lubrication with a light mineral oil does reduce wear—but below 2000 psi it increases the starting friction, compared with dry conditions.
- Increasing the ambient temperatures decreases the kinetic coefficient of friction.
- A shaft finish of 4 to 8 microin produces longest wear.

Williams' investigation, on the other hand, was aimed at high-temperature applications. He found that:

- For temperatures up to 550 F, a patented PTFE lining gave maintenance-free performance with five times' greater life than that of lubricated metallic bearings. This special liner has two layers bonded together: the inner is made of PTFE fibers woven with glass fibers; the backup layer is a resin-impregnated woven fiberglass.
- Longest life is obtained by using thinner liners (0.013 in.), by precompacting, and by having a high interference fit (approximately 0.002 in.) between shaft and inner bearing dia. The interference fit reduces the effect of high initial wear. After a short run-in, final fit is snug.

Oil-mist lubrication for ball bearings

Tests on a new type of ball-bearing fatigue-life tester, by E. A. Baniak and G. A. Kohl of Texaco, Beacon, NY (61 AM 4B-2) showed oil-mist lubrication gives significantly longer fatigue life than flood-lubrication. This surprising result was obtained with all oils tested, and for heavily loaded conditions, indicating that method of lubrication is the key to obtaining maximum life. Size R-4 instrument bearings were employed.

Another interesting conclusion by the experimenters: the lower viscosity oils gave longer fatigue lives than the higher viscosity oils—though there is not sufficient data to prove this conclusively.

Lubricant recommendations

The great majority of machine tools and prime movers can be properly lubricated with products falling within the classifications given in the table below. Developed by H. E. Tiffany of Sun Oil Co, Philadelphia (61 AM 3C-2), the table rates importance of various specifications by classing them in three catagories.

RELATIVE IMPORTANCE OF LUBRICANT SPECIFICATIONS

Lubrication Specification	Turbines	Hydraulics	Circulating Systems	Gearboxes: Worm	Gearboxes: Hypoid	Gearboxes: Other	Spindles	Ways	Motors	I.C. Engines	Compressors
Flash point	3	3	3	3	3	3	3	3	3	2	2
Fire point	3	3	3	3	3	3	3	3	3	2	2
Viscosity	1	1	1	1	1	1	1	1	1	1	1
Viscosity index	3	2	2	3	3	3	3	3	3	2	3
Pour point	3	2	2	2	2	2	3	3	2	1	2
Anti-rust	1	1	1	2	2	2	1	2	1	1	1
Anti-corrosion	1	1	1	1	1	1	1	1	1	1	1
Oxidation stabil.	1	1	1	2	2	2	2	3	1	1	2
Demulsibility	1	1	1	3	3	3	1	3	1	3	3
Extreme-pressure characteristics	3	3	3	1	1	3	3	1	3	3	3
Detergency	3	3	3	3	3	3	3	3	3	1	3
Saponification No.	3	3	3	1	3	3	3	3	3	3	3
Anti-foam	1	1	1	1	1	1	1	3	1	1	3

1 = Prime importance; 2 = Secondary importance; 3 = Little or no importance

Improving ball-bearing grease performance

When two greases of the same chemical type and with approximately the same consistency—but differing in thickener content—were tested, the grease with more thickener gave significantly longer ball-bearing life.

This held true for 13 products, including lithium and sodium soap-thickened petroleum greases and non-soap thickened silicone greases. It also held true from 100 C to 175 C, and for speeds from 3600 to 7000 rpm.

The tests were conducted by A. A. Schwartz of GE, Schenectady (61 AM 3B-3). Bearings employing the grease with higher thickener content had life spans generally from two to four times longer. He found it surprising that no one has tried a similar study and attributed his results to actual tests with ball bearings rather than using the typical lubricant bench tests.

Silicone lubricants offer low bearing torque

Three classes of lubricants—silicones, polyalkylene glycols and petroleum oils—were studied by Paul Lewis of GE, Schenectady (61 AM 2C-1) to determine which lubri-

cant properties have greatest influence on power losses in lightly loaded, small ball bearings. Lewis found that:

- Bearings lubricated with silicones exhibit a longer coastdown time. Hence, silicones have much lower torque characteristics than the petroleums or polyalkylene glycols. This effect is more pronounced with high-viscosity oils.
- Silicone's high performance may be caused by its reversible loss in viscosity under high rates of shear.
- Bulk viscosity and lubricating properties of a lubricant have no major effect on torque—contrary to popular belief.

New list of approved fire-resistant fluids

Fire-resistant hydraulic fluids have been available for some time but there are no universally accepted standards. A Bureau of Mines study reported by S. P. Polack (61 AM 3A-3) should prove of interest to other industries.

Polack disclosed that the vast majority of fluids employed today propagate flame when ignited. He summarized the generic types of the fire-resistant fluids now available, and in a later interview with PRODUCT ENGINEERING released this new list of fluids approved by the Bureau.

FIRE-RESISTANT HYDRAULIC FLUIDS APPROVED BY BUREAU OF MINES

Company	Product
Shell Oil	Shell SL-7361 FRM Fluid
Celanese Chemical	Cellulube 90, 150, 220, 300, 550, 1000
Socony Mobil Oil	TL 10; TL9
Hulburt Oil & Grease	Hulburt FRF-32—brand changed to Hul-E-Mul
Atlantic Refining	HYDRAULIC-FRC
Monsanto Chemical	Pydraul F-9
Gulf Oil	Gulf FR
Sun Oil	Sun Minesafe
Texaco	Texaco TL-4625
Humble Oil & Refining	WS-4292 Hydraulic Fluid
Sinclair Refining	Duro F-R 60
American Oil	AMOLIND

Wear equations evaluate ball-bearing steels

A new abrasive-wear testing technique helped establish new wear equations for ball-bearing steels. It also provides data on how useful a steel will be under sliding conditions.

Developed by E. Rabinowicz of MIT, and L. A. Dunn and P. G. Russell of Alloyed Corp, Cambridge, Mass (61 AM 4A-3), the apparatus injects abrasive particles between two wear specimens. The specimens are cleaned, and weighed for wear loss after each test period. The apparatus offers very good reproducibility, and the abrasive-wear method seems to minimize fluctuations in wear rate caused by changes in grain size and level of impurities. This permits detailed study of the effect of variations in heat treatment, such as annealed, hardened and tempered.

Tests were performed on three widely different types of rolling-contact bearing steels: 52100, a chromium steel; M-50, a vacuum-melted high-speed molybdenum tool steel; and 440 C, a martensitic stainless steel.

Data from tests have led to the wear equation:

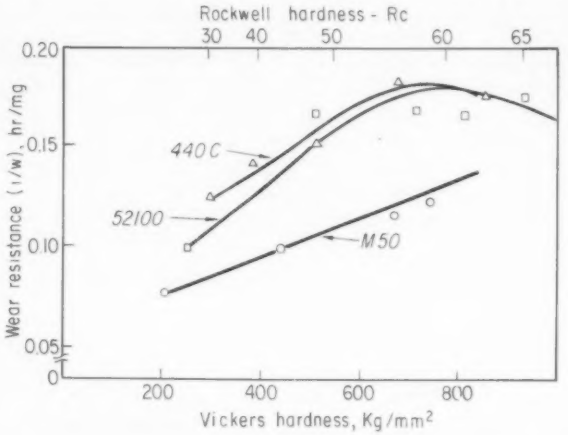
$$E^a H^b = C/W$$

where E = elastic limit, psi; H = Vickers hardness, kg/mm²; W = abrasive wear rate, mg/hr; and constants a and b are both fractions.

- For 52100 steel, the constants were found to be:

$$a = 0.10 \text{ and } b = 0.18$$

By knowing the wear rate for a 52100 steel at any hardness and elastic-limit values, the constant C can be calculated and then employed to predict wear at other hardness and elastic-limit values. The equation also can predict



the change in wear rates between two different heats of 52100 steel without the need for solving for C.

- For 440 C: $a = 0.03$ and $b = 0.28$
- For M-50: $a = -0.05$, $b = 0.55$

The 440 C and 52100 steels outperform the M-50 steel. There is also an optimum hardness value, approximately R_c60, for the two top performers.

Computing film thickness in gears and bearings

Data from a new X-ray technique is providing a clearer picture of the thin oil films, 5 to 50 millionths of an inch, which exist under concentrated-load conditions found in gears and rolling-contact bearings. The data confirmed the accuracy of an equation for predicting film thickness.

Developed by Battelle Memorial Institute, and reported by L. B. Sibley and F. K. Orcutt (61 AM 3B-2), the technique directs a square, parallel, monochromatic beam of X-rays at the contact between two lubricated, rolling-disk surfaces. The amount of the X-ray beam that passes through the lubricant-filled gap is measured by a radiation counter and is proportional to film thickness.

In an interview with PRODUCT ENGINEERING, Sibley presented a more workable equation for film thickness. A thickness of 5 to 10 microin is desirable:

$$h_0 = 0.057 \left[\frac{(\mu_0 \gamma V)^2 E' R}{P'} \right]^{8/11}$$

where h_0 = film thickness, μ_0 = viscosity at ambient temperature and pressure, V = sum of surface velocities at contact, P' = load per unit width of contact or ⅔ of elliptical contact width, γ = pressure coefficient of viscosity, and

$$E' = 1 \Big/ \left[\frac{1 - \nu_1^2}{\pi E_1} + \frac{1 - \nu_2^2}{\pi E_2} \right]$$

where E = modulus of elasticity, and ν = Poisson's ratio. Values of γ are obtainable from "Pressure-Viscosity Report," ASME, New York (1953).

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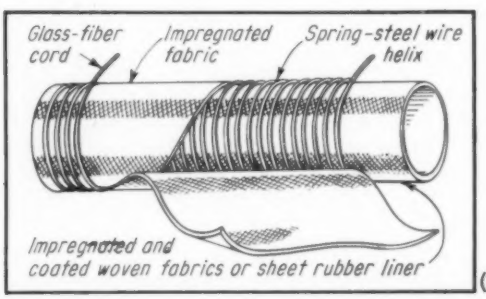
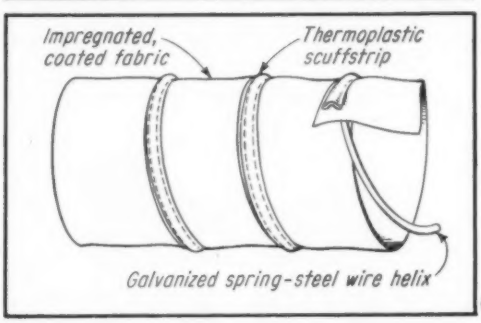
how to put FLEXIBLE TUBING to work

It solves many design problems through its ability to conduct air, liquids, dust, and granular solids through cramped passages and around obstructions, in a variety of environments.

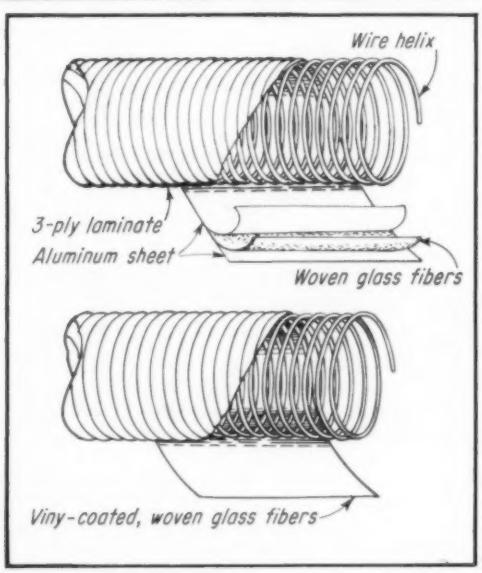
G WILLIAM LOVEDAY, *assistant to president, Flexible Tubing Corp, Guilford, Conn*


Glass-fiber cord
Impregnated fabric
Spring-steel wire helix
Impregnated and coated woven fabrics or sheet rubber liner

(A)



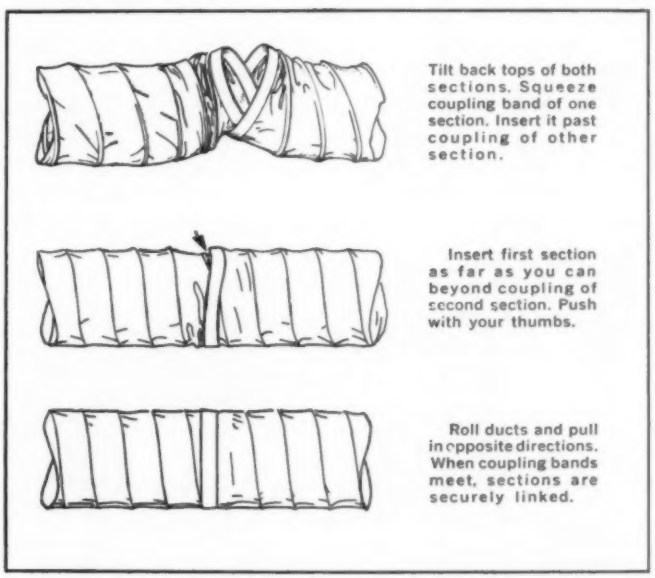
(B)



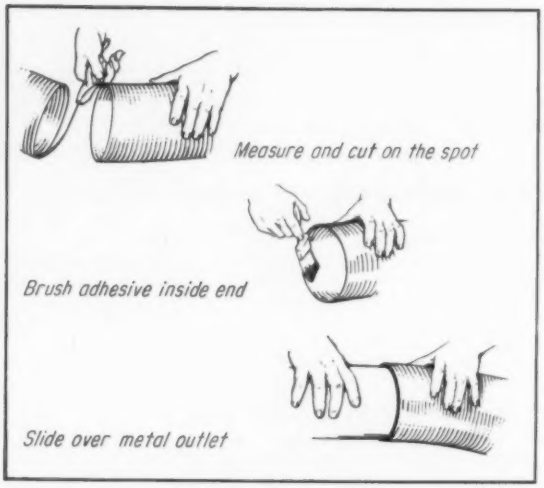
(C)

BASIC TYPES OF FLEXIBLE-TUBE CONSTRUCTION. For ventilation, fume-removal and materials-handling systems, construction (A) is preferred. Lightweight, portable ducting (B) is for miscellaneous fume- and dust-removal and materials handling. Two types of extra-flexible tubing (C) are designed for high-velocity air-conditioning systems and similar applications. This tubing can bend with a radius equal to half the diameter of the tubing.

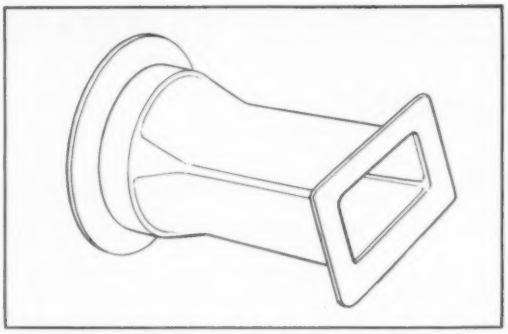
JOINTS require no special fittings; for tubing in (B) just follow the three steps shown below.


Tilt back tops of both sections. Squeeze coupling band of one section. Insert it past coupling of other section.
Insert first section as far as you can beyond coupling of second section. Push with your thumbs.
Roll ducts and pull in opposite directions. When coupling bands meet, sections are securely linked.

continued, next page

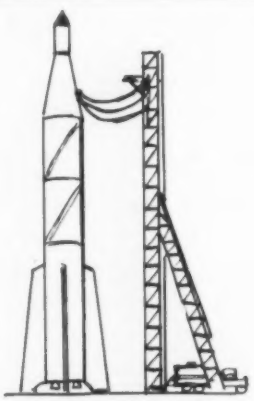


ADHESIVE CONNECTIONS for flexible ducting are quick, simple to make; require no additional sealing.

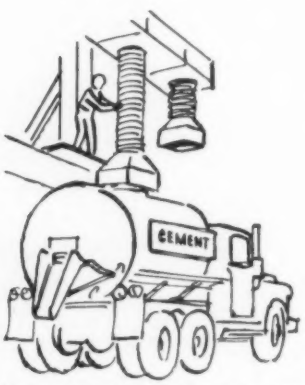


SPECIAL END-SHAPES are available for specific design requirements.

SOME OF THE JOBS that flexible tubing can do are shown in the following diagrams.

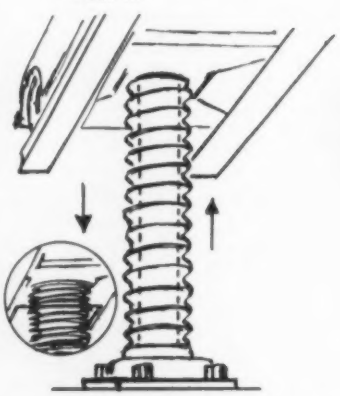


Piping liquids at −317 F.

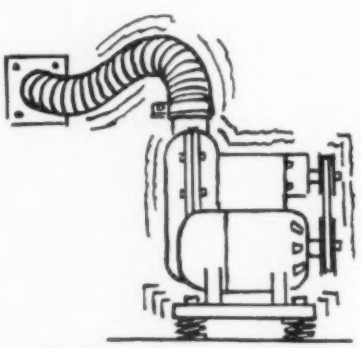


Lightweight ducting for cement, grain and other granular solids.

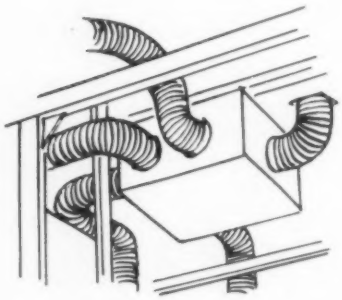
For easy handling, ducting up to 25 ft. long can be compressed accordion-style and carried by one person.



Tubing seals out dust from retractable screw or other similar devices.



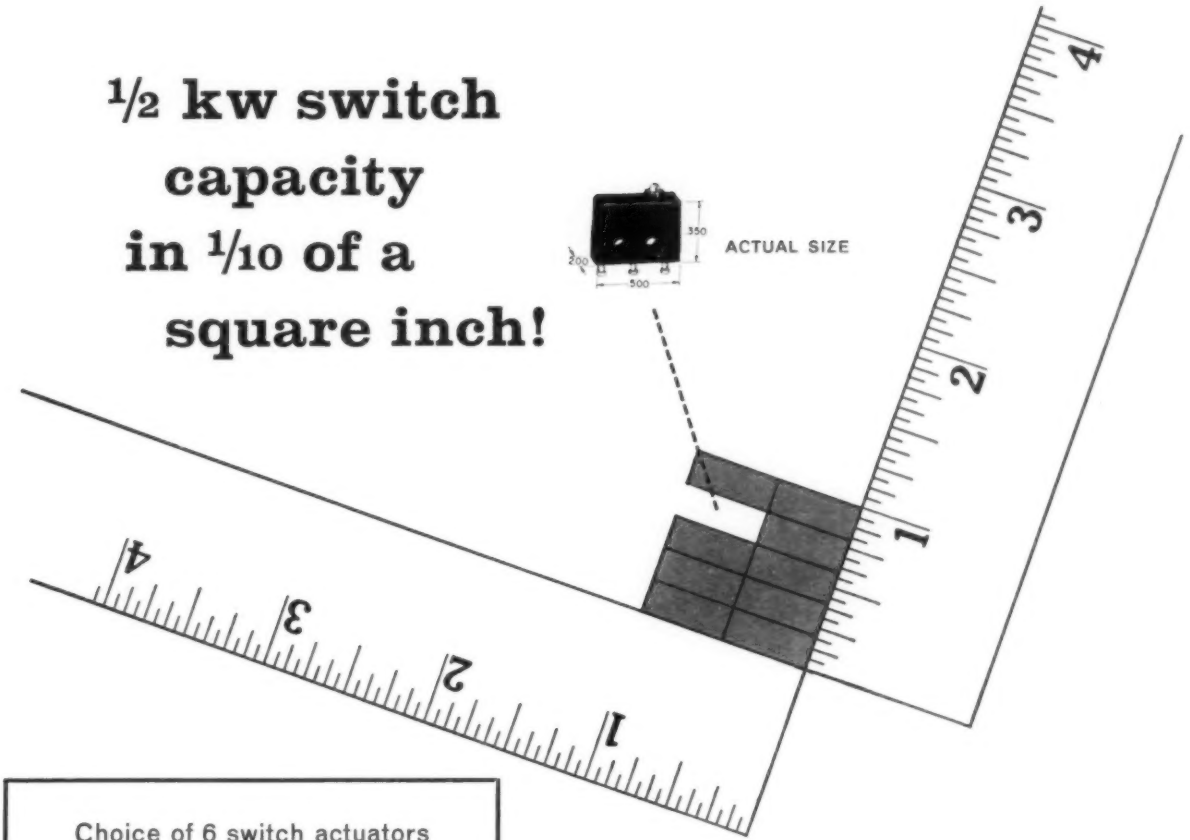
High vibration resistance of flexible tubing makes it suitable for many dust- and fume-carrying jobs.



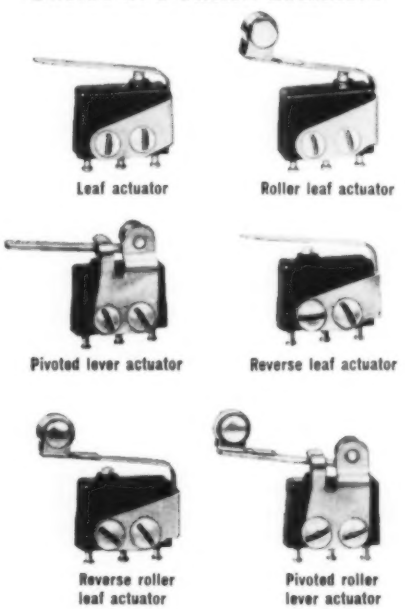
Where space is limited, "snake" the flexible tubing around corners with little loss of airflow.

MICRO SWITCH Precision Switches

½ kw switch capacity in 1/10 of a square inch!



Choice of 6 switch actuators



THE MICRO SWITCH "1SX1" is the smallest single-pole double-throw snap-action switch made. It weighs only 1 gram. Yet, despite its tiny size, it performs millions of operations, in temperatures ranging from −65° F. to +250° F. And it handles precision switching jobs at capacities up to ½ kw.

The case, cover and plunger are made of high-strength plastic. Contacts are fine silver. The unique, snap-action spring is beryllium copper. The case has two mounting holes that accept No. 2 screws. One hole is slightly elongated to facilitate mounting. "1SX1" is designed to conform to MS24547-1.

MICRO SWITCH manufactures a complete line of small basic switches. See the Yellow Pages for your nearby MICRO SWITCH Branch Office. Or write for Catalog 63.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

HONEYWELL INTERNATIONAL
Sales and service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

CIRCLE 103 ON READER SERVICE CARD

CIRCLE 104 ON READER SERVICE CARD →

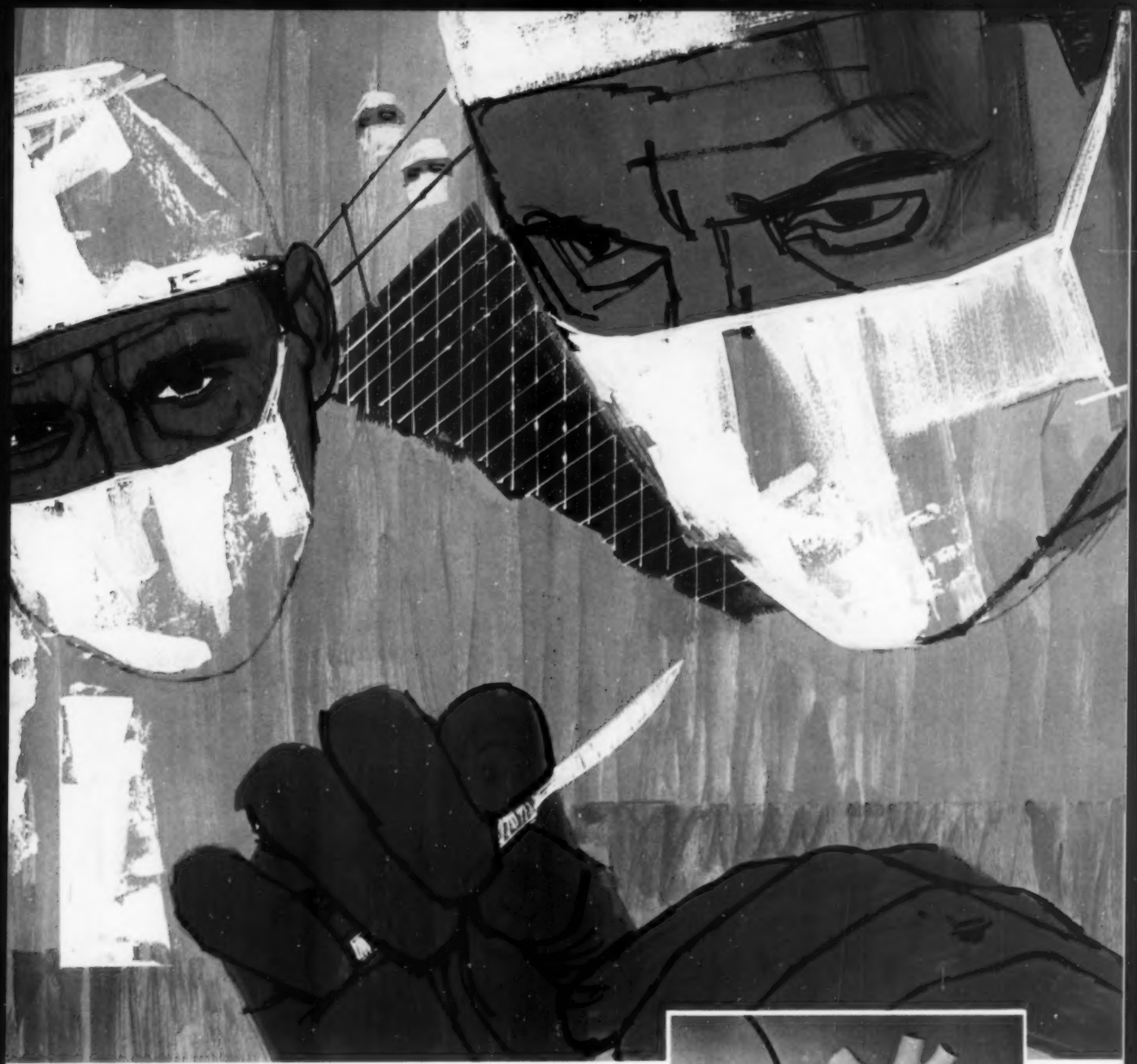
NS SPECIAL WIRE TRANSMITS

Doctors are saving more lives today in heart surgery cases through the transmission of carefully timed electrical pulses into the heart. Many patients suffering from lost heartbeat due to surgery or other causes have been restored to active life through such heart stimulation.

A LEADING MEDICAL INSTRUMENT COMPANY developed a pocket-size electronic package to generate the electrical impulse, which is transmitted to the heart through the jugular vein by a tiny stainless steel braided wire.

In their search for the right conductor to carry the electric pulses to the heart, researchers came to National-Standard for help in developing a wire flexible enough to follow the intricate path of the circulatory system, while, at the same time, soft enough to avoid damaging the blood vessels or the heart itself. In addition, the wire had to be very thin, strong enough to withstand the constant flexing of the heart, and with just the proper electrical characteristics.

NATIONAL-STANDARD ENGINEERS developed a braid of 16 wires, each .0036″ diameter, or about the thickness of human hair. Using type 302 stainless



SPARK OF LIFE

steel wire, NS engineers produced a braided wire with high tensile strength, good resistance to fracture, good conductivity and flexibility just right for the delicate application.

EXPERIENCED ENGINEERING HELP of this kind, for jobs requiring high-quality wire, to meet special or unique applications, is available to you from National-Standard. Write for additional information to National-Standard Company, Niles, Michigan.

NS NATIONAL-STANDARD COMPANY

Manufacturer of Specialty Wire and Metal Products

NATIONAL-STANDARD COMPANY

Niles, Michigan

NS SPECIAL WIRE transmits spark of life from transistorized, battery-powered package, through jugular vein, to the heart. Carefully timed electrical pulses train tired hearts to beat normally again.

IF A *MINIATURE* OR *INSTRUMENT* BEARING IS NEEDED . . .

NEW HAMPSHIRE

. . . IS THE *SOURCE!*

To meet the exacting requirements of your applications, New Hampshire maintains a full line of miniature and instrument bearings for research and development, prototypes and replacements at all regional offices. (Production quantities are shipped direct from our main plant.) NHBB sales engineers are always on call to discuss your particular needs and make specific recommendations.

RETAINER BEARINGS

Retainer Bearing Plain

Retainer Bearing Flanged

Retainer Bearing Shielded

Retainer Bearing Flanged & Shielded

This is one of the most frequently specified types for instrument applications. Available with newly designed crown retainers. This design permits even ball spacing, low torque, and most consistent performance. *Over 370 standard types and sizes are listed in our Design Manual.*

SIZES

(Available in a wide selection of combinations within the following ranges)

	BORE	O.D.	WIDTH
Min.	.0400	.1250	.0469
Max.	.3125	.6250	.1960

EXTENDED INNER RINGS . . . available on all above types

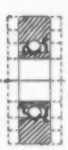
FULL BEARINGS

Full bearing (Available plain or flanged)

Specified for applications requiring maximum radial load capacity. Not suited to low torque requirements. *Over 21 standard types and sizes.*

SIZES	BORE	O.D.	WIDTH
Min.	.0250	.1000	.0312
Max.	.3125	.5000	.1562

UP and WAFER BEARINGS



A wafer bearing compared with standard equivalent

Expressly designed for use in synchros, servos, small motors, potentiometers, and gear trains. Widths are significantly narrower than standard to allow more room for rotors and stators. *Available in 16 types and sizes.*

SIZES:	BORE	O.D.	WIDTH
Min.	.0550	.1875	.0937
Max.	.1875	.4375	.1094

QUALITY PERFORMANCE . . .

is in direct relation to quality of production. *All New Hampshire bearings* are made to ABEC-7 tolerances or better. The result is *improved running qualities* for all users . . . at no extra cost! In addition, rigid quality control during manufacture and continuing research enables New Hampshire to maintain leadership in our field . . . to supply you with the finest bearings for your needs at the lowest cost.

IMMEDIATE DELIVERIES FROM STOCK . . .

(For research & development, prototypes, and replacements) are made from our three regional offices as well as the main plant. Bearing specialists are on hand to help you plan and specify. Call your nearest office collect for fast service.

NEW HAMPSHIRE BALL BEARINGS, INC.

51 Cutter Mill Road
GREAT NECK, NEW YORK
HUnter 2-8633 TWX: 1421U

566 Northwest Highway
DES PLAINES, ILLINOIS
VAnderbilt 7-6646 TWX: 1642U

1540 North Highland Avenue
HOLLYWOOD 28, CALIFORNIA
HOllywood 4-0208 TWX: LA 933U

(main plant)
PETERBOROUGH, NEW HAMPSHIRE
WAlnut 4-3311 TWX: 209U

NEW DESIGN MANUAL

Newly revised and expanded, this authoritative publication is a guide to designing around, specifying and purchasing of miniature and instrument ball bearings. Comprehensive general information, catalog data, and engineering bulletins are included in the 100-plus pages. A personally registered copy is available to qualified engineers, draftsmen, and purchasing departments.

For your free Design and Purchasing Manual, write or call any New Hampshire Office.

NEW HAMPSHIRE BALL BEARINGS, INC.

PETERBOROUGH, N. H.

TEAR ALONG PERFORATION AND FOLD ON CENTERLINE →

iniscent of the king's hunting lodge. Smörgasbord and Continental menu in the evening; steaks also a specialty. Surprisingly reasonable. Reservations advisable.

Kingsley Inn: Woodward at W Long Lake Road, Bloomfield Hills

Hangout of top auto and advertising executives. Excellent food but expensive. Entertainment and dancing nightly. A dignified, dressy place.

CANADA (When in Detroit why not take 10 minutes by bus or cab through a tunnel and visit Canada? The thriving city of Windsor offers worthwhile discounts on imported trinkets, but keep the purchase under $10—customs duties wipe out savings above this amount.) While there try:

Al Siegal's Elmwood: Dougall Road on Highway 3 (10 minutes out of Windsor)

Mammoth night spot that always features top name entertainment. Excellent meals are surprisingly reasonable. Dancing. Adjacent motel.

PRODUCT ENGINEERING

WHERE TO EAT IN DETROIT . . .

HOTELS

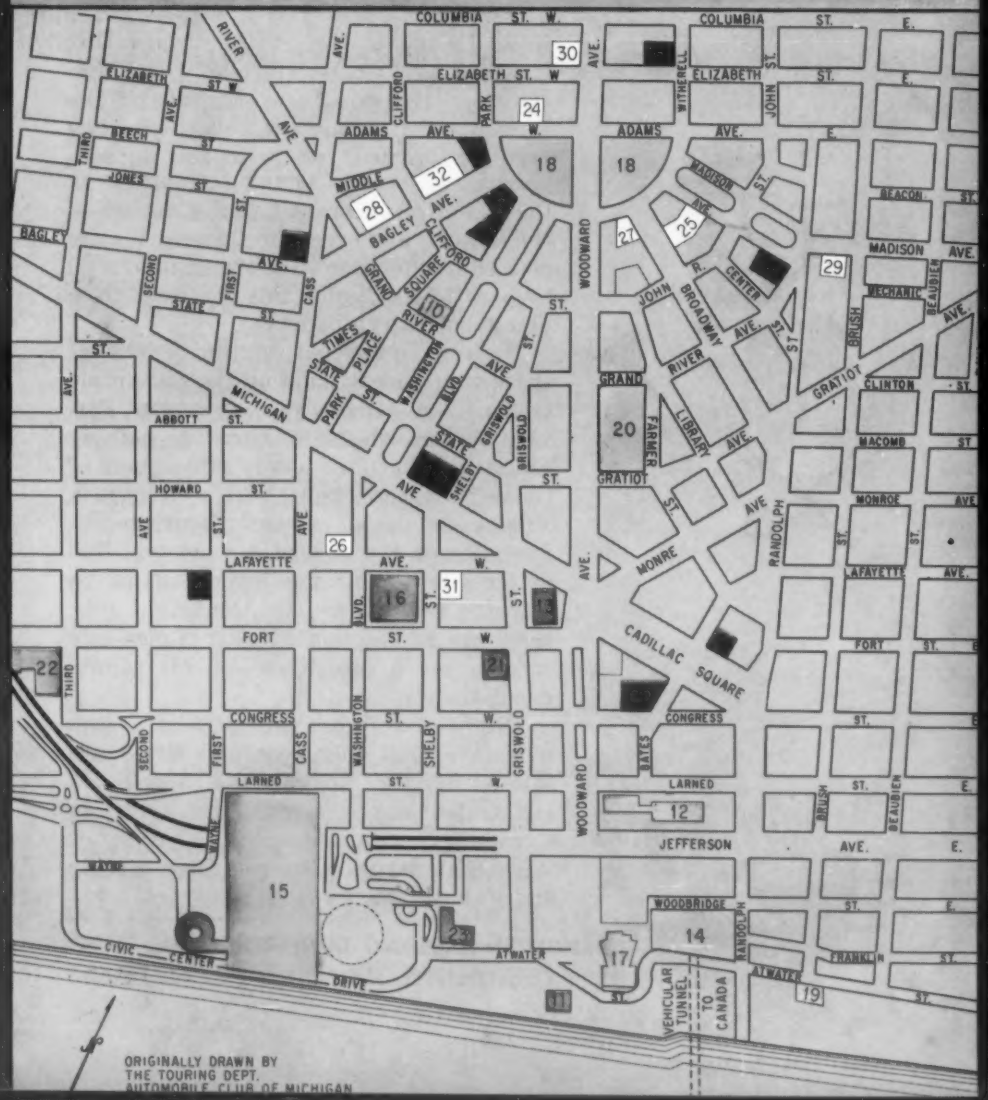
1 . . DETROIT-LELAND
2 . . FORT SHELBY
3 . . HENROSE
4 . . IMPERIAL
5 . . MADISON-LENOX
6 . . SHERATON-CADILLAC
7 . . STATLER
8 . . TULLER
9 . . WOLVERINE

BUILDINGS

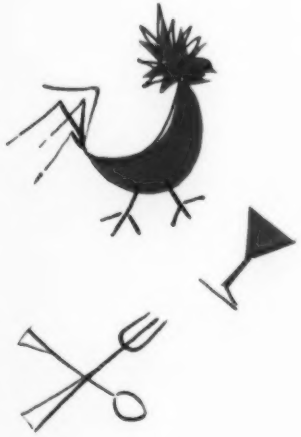
10 . . AIRLINE BUS DEPOT
11 . . BOB LO STEAMERS
12 . . CITY-COUNTY BUILDING
13 . . CITY HALL (OLD)
14 . . DETROIT WINDSOR TUNNEL
15 . . EXHIBITION (COBO) HALL
16 . . FEDERAL BUILDING
17 . . FORD AUDITORIUM
18 . . GRAND CIRCUS PARK
19 . . GRAND TRUNK DEPOT
20 . . J. L. HUDSON COMPANY
21 . . PENOBSCOT TOWER
22 . . UNION DEPOT
23 . . VETERANS' MEMORIAL

THEATERS

24 . . ADAMS
25 . . BROADWAY CAPITOL
26 . . CASS
27 . . MADISON
28 . . MICHIGAN
29 . . MUSIC HALL
30 . . PALMS STATE
31 . . SHUBERT LAFAYETTE
32 . . UNITED ARTISTS



ORIGINALLY DRAWN BY
THE TOURING DEPT.
AUTOMOBILE CLUB OF MICHIGAN



Good Eating is one of the things that makes traveling worthwhile. Don MacDonald, McGraw-Hill's Detroit News Bureau chief, is always being asked by "visiting firemen" where to eat. In self-defense, he started trying restaurants in the downtown area and slowly spread to the suburbs and even into Canada. We are pleased to offer Don's recommendations on "Where to Eat," plus this comment from him about entertainment:

"Detroit, somewhat to the dismay of those who wish to build up the convention traffic, is a genuinely clean town. Fortunately or otherwise, there is nothing remotely akin to the bawdy atmosphere of Chicago's Cicero, New York's Greenwich Village or New Orleans' Bourbon St. Devotees of the ecdysiastic art will find better sport amidst the lingerie ads in the morning newspapers. On the bright side, there are no clip joints and it is perfectly safe to ask a cab driver for his recommendations.

"Night clubs close promptly at 2 a.m. weekdays, and only beer and wines are sold on Sunday. Roughly the same hours and rules apply across the river in Canada."

With that, let us wish you Good Eating and Fun at the

DESIGN ENGINEERING CONFERENCE AND SHOW

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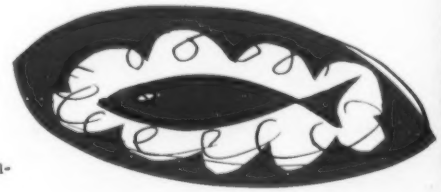


around it. German specialties. Fairly reasonable. Closed Sundays.

Mario's: 4222 Second

Colossal Italian meals without the checkered tablecloth atmosphere. The free antipasto, which is the first of about six courses, would fill most people. Wide price range. Not open for lunch. Reservations essential.

Terova's Rathskeller: 6521 John R.

Large and busy, but still careful with cuisine and service. German specialties featured, as well as good steaks. Not too expensive. Reservations essential.

Topinka's: 2560 W Grand Blvd

Beamed ceilings offer noisy privacy. Perhaps the most popular lunch spot in the busy General Motors Building area. More relaxed in the evening, with smörgasbord. "American" cooking for lunch. Reasonable.

SUBURBAN RESTAURANTS (long way out but listed because they are really worth the trip.)

Al Green's: 15301 E Jefferson, Grosse Pointe

Home stand of a nationally known caterer. Several separate dining rooms, with the newest featuring Polynesian delicacies. Dancing. Expensive.

Topinka's Country House: 24010 W 7 Mile, Detroit

Plush, large new restaurant with a decor rem-

the place where Luigi takes Mama for spaghetti on her night out. In the heart of Detroit's picturesque farmer's market. Very reasonable.

Roostertail: Foot of Marquette, off E Jefferson

One of Detroit's newest and glossiest restaurants, almost on the scale of New York's Latin Quarter. Name entertainment featured nightly. Glassy modern, smack on the Detroit River. It's worth sitting there just to watch the freighters go by. Good but expensive food. Dancing. Reservations at night.

Safari Land Nairobi Steak House: 5830 Connor

Where cast-iron stomachs are put to the test. Buffalo, elk, venison and moose regulars on the menu. Rattlesnake steak, stuffed monkey and alligator tail requires two days notice. Seafood and American dinners also served daily 11:00 to 11:00 PM. Food and cocktails served in rugged atmosphere. Closed Mondays. Reasonable.

Housey's Chop House: 503 E. Jefferson

Steak and chops the speciality at a real bargain. Piano bar with entertainment Friday and Saturday nights. Closed Sunday. Hospitable, relaxed. Reservations helpful at lunch.

Boesky's: 20231 James Couzens

A fairly long trip, but when you get there you'll find the best Kosher food west of New York's Lindy's. Brand-new, plush, and a testimony to the success of Mr Boesky's original downtown delicatessen. Reasonable.

Schweizer's: Foot of Hastings, off E Jefferson

One of Detroit's oldest and most revered, to the point where a new expressway was routed

RESTAURANTS

DOWNTOWN (lunch, dinner and bar unless otherwise noted)

London Chop House: 153 W Congress

One of the top 10 restaurants in the country; Detroit's only one so listed by *Holiday* magazine and others. Reservations essential. Expensive, a la carte. Beef in all its forms a specialty, but top gourmet quality throughout the extensive menu. Dancing evenings.

Caucus Club: 150 W Congress in Penobscot Building

Run by the London Chop House people. Famous for 24 varieties of king-size sandwiches unobtainable anywhere else. Its fine bar has spawned more than its share of nationally ordered exotic drinks. Fairly expensive. Reservations necessary at noon. Soft music at night.

Pontchartrain Wine Cellars: 234 W Larned

Thoroughly and genuinely French in both decor and cuisine. Food is served with vintage wines; you have to fight for a glass of water. No liquor. Quite reasonable.

Richlieu's: 1033 Washington Blvd

Attractive, intimate atmosphere with good food in the middle-price range. Hospitable; good service. Trio performs most evenings for dancing.

Eastman's Gaslight: 441 Grand River

No relation to key clubs in Chicago, etc, but stands on its own merit for good food. Victorian atmosphere and American cooking. Fairly expensive. Evening dancing.

Knife and Fork Club (formerly Yeaman's): 516 Howard

Lively Detroit showplace with excellent food

and supersize drinks. Need reservations during meal hours. Mammoth salads a specialty at lunch; name entertainment featured in evening along with dancing. On the expensive side.

Berman's Chop House: 1431 Times Square

Reasonable, excellent steaks are the specialty. Always crowded, always noisy, but never too long a wait for a table. A favorite of Detroiters themselves.

Cliff Bell's: 2030 Park

Literally an oak-paneled picture gallery turned into a deluxe restaurant, although the food came first. Celebrities gravitate here. Dancing evenings, but always lively. Fairly expensive.

Victor Lim's: 48 W Adams

Ostensibly Chinese, but the proprietors became famous and prosperous, and now serve almost any dish in a truly deluxe atmosphere. Any drink known to Trader Vic is served here—very often to visiting stage and screen stars. Reasonable.

Stouffer's: 1501 Washington Blvd

Part of the well-known chain, with mass-produced food and drink of excellent quality. Nice atmosphere. Very reasonable. For those who want to "eat and git," or for wives on their own.

Sofferin's Wonder Bar: 1221 Washington Blvd

A misnomer for a good restaurant featuring American cooking. The separate bar is a lively place, and there is dancing and entertainment in the dining room evenings. Middle priced.

Gurney's Chop House: 28 E Congress

Most often have a good German dish on the menu, plus excellent steaks. Noisy, sometimes rowdy as a result of insistence on keeping decor and fixtures dating back 50 years. Argue with the waiters and enjoy yourself. Reasonable.

Karsten's: 1550 Woodward

Just about Detroit's best cafeteria downstairs, and upstairs is the Cascade Room for leisurly lunch and drinks. Somewhat tea-roomy, and therefore a favorite of downtown shoppers. Reasonable.

NEAR DOWNTOWN (lunch, dinner and bar unless noted otherwise)

Joe Muer: 2000 Gratiot

Just about the best and biggest seafood house away from the ocean. Also lake fish specialties. Reservations useless but the lines move fast except on Friday. Seasonal items flown in fresh daily. Quite reasonable and caters to children.

Stockholm: 1014 E Jefferson

As the name implies, features a delicious and inexpensive smörgasbord. Quiet surroundings, with the emphasis on gorging.

Carl's Chop House: 3020 Grand River

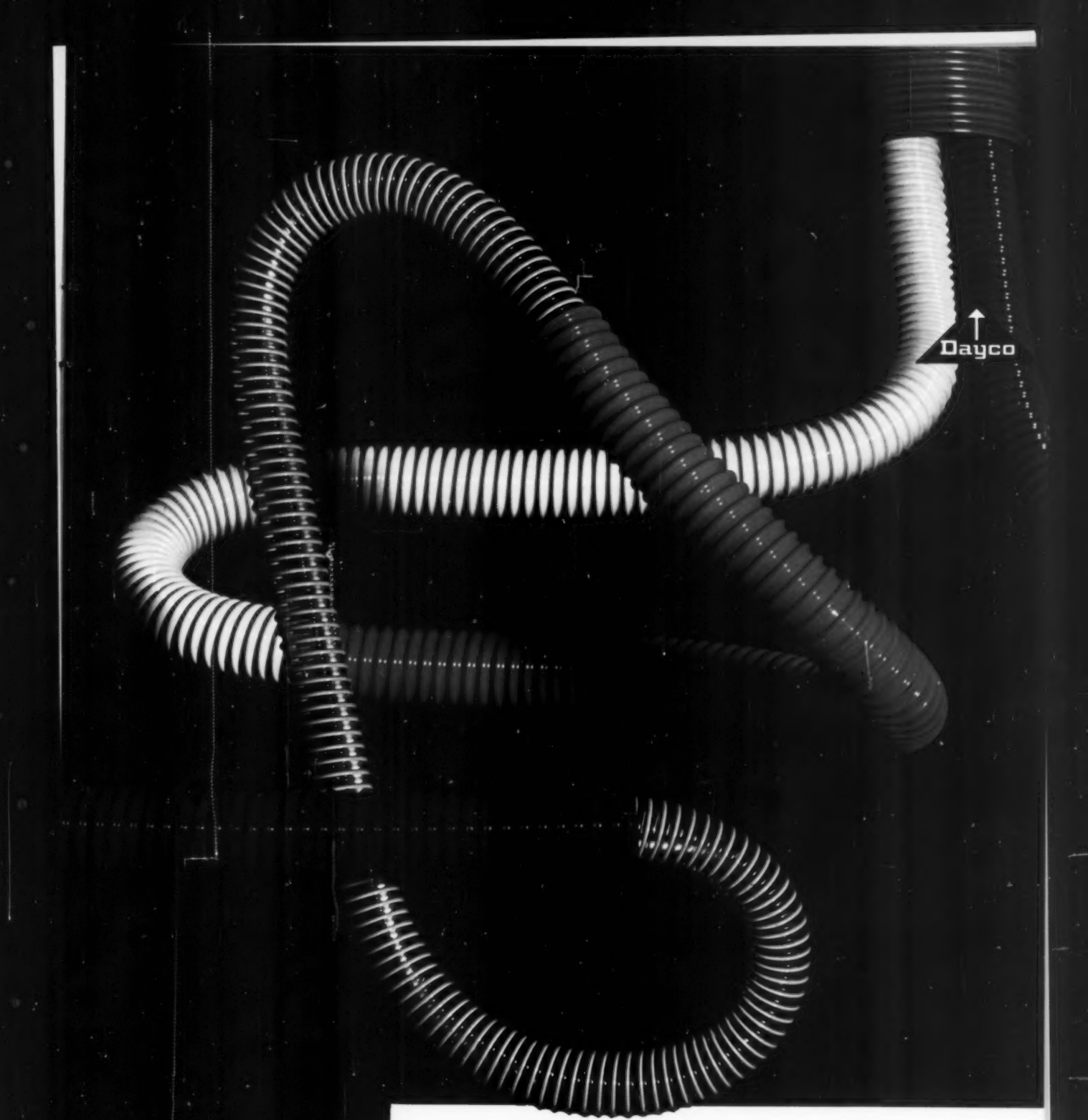
Carl buys most of his beef from prize-winning 4-H'ers, and butchers and ages it himself. It's good and surprisingly inexpensive. Newly and plushly decorated. Reservations helpful.

Little Harry's: 2681 E Jefferson

This beautiful old New Orleans-style building was for 48 years the home of one of Detroit's leading families. Then it became a speakeasy, and since Repeal has been a fine restaurant. Steaks and seafoods nicely served in a dining room with a fireplace. Piano bar. Expensive

Roma Cafe: 3401 Riopelle

Detroit's oldest Italian restaurant, and still



INVESTIGATE

DAYCO'S DAYFLEX PLASTIC HOSE

Wherever low pressure or vacuum transfer is used to move liquids, gases, or solids, Dayco has a durable, non-collapsible, lightweight, flexible hose to do the job better. Available in every color and a wide range of diameters and lengths.

never before

low pressure or vacuum hose with all these desirable, all-purpose properties

high tensile strength · lightweight · maximum flexibility · long life · non-collapsibility · chemical and abrasion resistance · stretchability · economy · in any color, including metallics · continuous lengths up to 50 feet, longer when coupled · diameters from less than ¼" to 4" and larger

FACTS
ABOUT FLEXIBLE PLASTIC VACUUM HOSE

FREE BOOKLET—Dayco research and sales engineers are at your service to develop or modify flexible plastic hose in production quantities to meet your specifications. For FREE BOOKLET and complete details, fill out coupon and mail today.

DAYFLEX® Dayflex plastic hose meets critical specifications of flexibility, ease of handling, light unit weight, and free flow within wide temperature ranges for consumer and industrial use.

*NYLAFLEX** Exclusive NYLON reinforcement in this plastic hose imparts increased flexibility as well as great tensile strength for longer life. Lightweight yet rugged. Bends in its own diameter. Chemical and abrasion resistant. Won't rust, rot, shrink, leak or collapse.

*ELECTROFLEX** A plastic hose with unique double wire core which provides added structural strength plus electrical capacity. Carries 110-115 volts. UL approved.

*MICROFLEX** Small diameter plastic hose is available in ¼" or similar diameters in lengths up to 6'. All lengths continuous with no splices.

VENT HOSE Designed for permanent installation in domestic and industrial applications. Fully insulated.

*DYNAFLEX** It is the toughest plastic hose of its type. Has amazing chemical and abrasion resistance. Safely carries liquid or vapor solvents at temperatures as high as 175° F.

*SWIMFLEX** The only floating plastic hose with corrosion-proof, non collapsible wire. Abrasion resistant, leak and mar-proof. Easy to clean.

*Trade Mark. Patented and Patents Pending.

SOME PRESENT USES

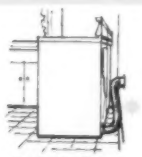
Resuscitator Oxygen Hose FDA Approved

Dayflex Current-Carrying Vacuum Hose

Flexible Hair Dryer Hose

Nylaflex Swimming Pool Hose

Industrial Vacuum Hose



Domestic Dryer Venting Hose

Also used for power sander hose, drain hose in house trailers, vacuum hose in record players, air hose for organs, coin transfer hose in vending machines, industrial vent hose.

DAYCO CORPORATION

Dayflex Plastics Division, Dayton, Ohio

Please send FREE BOOKLET with facts on flexible plastic hose.

name_____

title_____

firm_____

address_____

city_____ zone____ state_____

Form No. PR-19-361

Dayflex Plastics Division

Dayco CORPORATION

DAYTON, OHIO (formerly Dayton Rubber)

Litho in U.S.A. 1259

GUIDE TO THE

1961 DESIGN ENGINEERING SHOW AND CONFERENCE

MAY 22-25, COBO HALL, DETROIT, MICHIGAN

Where to Eat in Detroit 107
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←CIRCLE 112 ON READER SERVICE CARD

DESIGN ENGINEERING CONFERENCE . . .

Sponsored by the ASME

MONDAY, MAY 22, 1961 . . . 10 am

DESIGNING FOR TODAY'S COMPETITIVE MARKET

MODERATOR: Eugene J. Hardig, Vice President and Chief Engineer, Automotive Division, Studebaker-Packard Corporation, South Bend, Indiana

SECRETARY: Henry B. Horldt, Chief Engineer, Special Machine and Engineering Inc, Detroit, Michigan

PANEL: **How a Car is Planned and Engineered with Marketing, Purchasing, Manufacturing and Quality Control Considerations,** by Will Scott, Executive Director of Central Product Planning Office, Ford Motor Car Company, Dearborn, Michigan

Designing for Function and Cost Objectives, by Herbert M. Bevans, Executive Engineer—Chassis, Electrical, Truck Section, Engineering Division, Chrysler Corporation, Detroit, Michigan

Production Engineering as it Effects Car Design and Sales, by Conrad F. Orloff, Assistant Chief Engineer, Production Engineering Department, Chevrolet Motors Division, General Motors Corporation, Detroit, Michigan

Role of the Supplier in Meeting Competition, by Carl E. Burke, Chief Development Engineer, American Motors Corporation, Detroit, Michigan

TUESDAY, MAY 23, 1961 . . . 9:30 am

MANUFACTURING—KEY TO SAVING

CO-CHAIRMAN: Fred R. Swanson, Chief Engineer—New Products Research, Sundstrand Machine Tool Division, Sunstrand Corporation, Belvidere, Illinois

Walter R. Opel, Chief Engineer, The Cross Company, Fraser, Michigan

61-MD-1 **Producibility—Designing for Production,** by C. Edward Warner, Manager-Advanced Manufacturing Engineering Service, and Robert L. Berg, Consultant-Producibility Engineering, General Electric Company, Schenectady, New York

61-MD-2 **Material Standardization to Reduce Costs,** by Gerald L. Swartwood, Material Engineer and Drafting Supervisor, The Bryant Electric Company, Bridgeport, Connecticut

AUTOMATIC EQUIPMENT—SPEEDS PRODUCTION

CO-CHAIRMAN: Edward I. Brown, Director of Engineering, Machinery Hydraulics Division, Vickers Incorporated, Detroit, Michigan

Earl A. Thompson, President, Earl A. Thompson Manufacturing Company, Ferndale, Michigan

61-MD-3 **Special Requirements of Hydraulic Circuits for Servo Controlled Machinery,** by Robert K. Sedgwick, Assistant Chief Engineer, Servo Division, Kearney and Trecker Corporation, Milwaukee, Wisconsin

61-MD-4 **Drives for Tape-controlled Machine Tools,** by George W. Younkin,, Chief Development Engineer, Giddings & Lewis Machine Tool Company, Fond du Lac, Wisconsin

GLASS AND CERAMIC—OFFER NEW DESIGN POSSIBILITIES

CO-CHAIRMAN: William R. Benn, Manager, Market Development Department, Research and Development Division, The Carborundum Company, Niagara Falls, New York

L. R. Larsen, Sales Development Engineer, The Beryllium Corporation, Reading, Penna.

61-MD-5 **Ceramic Materials: A Chemical and Structural Description,** by Dr Marvin G. Britton, Technical Manager, Government Services Department, Corning Glass Works, Corning, New York

61-MD-6 **What Do Glasses and Ceramics Offer the Design Engineer,** by John R. Blizard, Manager, Product Engineering Department, Technical Products Division, Corning Glass Works, Corning, New York

COBO HALL—DETROIT

Machine Design Division

HIGH STRENGTH STEEL—IMPACT OF RECENT DEVELOPMENTS

CO-CHAIRMAN: Charles B. Salter, Chief Engineer, Weapons Systems, United States Army Ordnance Tank-Automotive Command, Detroit, Michigan

Ralph G. Gillespie, Advertising Director, Brooks & Perkins Inc, Detroit, Michigan

61-MD-7 **High Strength Steels—Part I, Materials,** by R. A. Lula, Chief Research, Metallurgist—Stainless Steel, Allegheny Ludlum Steel Company, Pittsburgh, Pennsylvania

61-MD-8 **High Strength Steels—Part II, Design and Fabrication,** by Richard H. Marvin, Chief Engineer, SpaceAtomics Section, Product Development Department, The Budd Company, Philadelphia, Pennsylvania

WEDNESDAY, MAY 24, 1961 . . . 9:30 am

MOTORS—ECONOMICS AND APPLICATIONS

CO-CHAIRMAN: Dr Forrest E. Brammer, Head, Department of Electrical Engineering, Wayne State University Detroit, Michigan

J. W. Picking, Manager, Control Division, Reliance Electric and Engineering Company, Cleveland, Ohio

61-MD-9 **Electric Motors at Higher Temperatures for Industrial Usage,** by Frank C. Rushing, Engineering Manager, Motor and Gearing Department, Westinghouse Electric Corporation, Buffalo, New York

61-MD-10 **Mechanical Application of Non-excited Synchronous Motors,** by J. P. Landis, Development Project Engineer, Electro-mechanical Development Section, Mechanical Development Laboratory, E. I. du Pont de Nemours & Company Inc, Wilmington, Delaware

PRODUCTION—COST SAVING HINTS

CO-CHAIRMAN: H. S. Cline, Manager, Mechanical Experimental Section, Mechanical Development Laboratory, E. I. du Pont de Nemours & Company Inc, Wilmington, Delaware

William L. Wachs, Manager of Engineering Service, Cimtrol Division, Cincinnati Milling Machine Company, Cincinnati, Ohio

61-MD-11 **Design Techniques for Simplified Programming of Numerically Controlled Machine Tools,** by Alexander Taleff, Equipment Development Engineer, Headquarters Manufacturing Laboratory, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania

61-MD-12 **Cost and Value of Small Tolereances and Smooth Finishes,** by Dr W. W. Gilbert, Manager, Machining Development Service, Manufacturing Engineering Service, General Electric Company, Schenectady, New York

ADHESIVES—FOR METAL BONDING

CO-CHAIRMAN: Nicholas J. DeLollis, Materials Engineer, Sandia Corporation, Albuquerque, New Mexico

Dr Sumner B. Twiss, President, Cycleweld Chemical Products Division, Chrysler Corporation, Trenton, Michigan

61-MD-13 **Adhesives: Types and Characteritsics,** by W. C. O'Leary, Technical Directors, Adhesives, Coatings and Sealers Division, Minnesota Mining and Manufacturing Company, St Paul, Minnesota

61-MD-14 **Factors in Joint Design Using Adhesives for Metal Bonding,** by Kenneth F. Charter, Director, Plastics Research, and Harry R. Butzlaff, Supervisor, Plastics Research, A. O. Smith Corporation, Milwaukee, Wisconsin

COST ANALYSIS—FASTENERS AND POWDER PARTS

CO-CHAIRMAN: Paul D. Frost, Chief, Metals Economics Research, Department of Metallurgy, Battelle Memorial Institute, Columbus, Ohio

Chalmers Dale, President, Charles Hardy Inc, New York, New York

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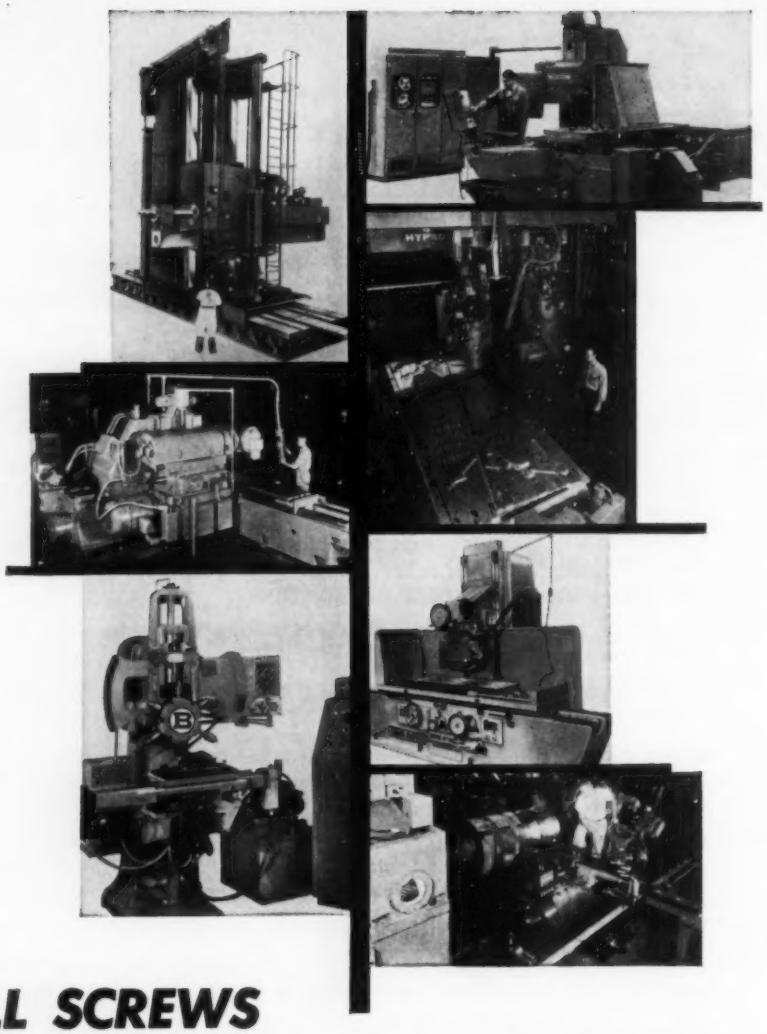
VISIT OUR BOOTH
#410

DESIGN
ENGINEERING
SHOW

DETROIT
MAY 22-25



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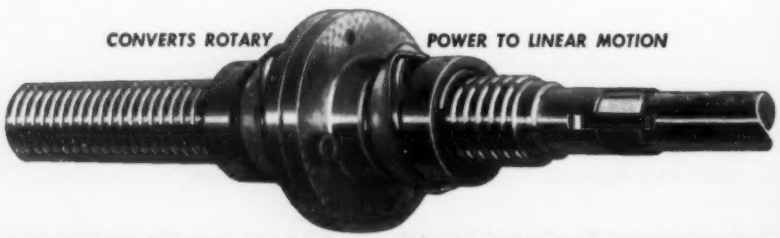
Beaver Ball Screws provide for the moving of massive loads or extreme small parts such as fuel metering devices with equal sensitivity. Our engineers will be glad to consult with you in determining where they may serve better than hydraulic, pneumatic or acme screw actuation in your product. Write for our catalog.



SPECIFIED BY 22 MAJOR MACHINE TOOL MANUFACTURERS

Largest manufacturers of precision ball screws

Beaver Precision Products INC.
CLAWSON, MICH.

61-MD-15 **Which Fastener Should We Choose,** by John W. Stoutenberg, Vice President, Robins Products Company, Warren, Michigan, and Kenneth D. Ringland, Chief Engineer, New England Division, Central Screw Company, Keene, New Hampshire

61-MD-16 **Designing With Powder Metallurgy to Improve Quality and Reduce Cost,** by Paul J. Failla, General Superintendent—Machine Shops, Johnson Bronze Company, New Castle, Pennsylvania

THURSDAY, MAY 25, 1961 . . . 9:30 am

PLASTICS—UNUSUAL BEHAVIOR

CO-CHAIRMAN: Dr John D. Young, Manager, Automotive Department, Polychemical Department, E. I. du Pont de Nemours & Company Inc, Michigan

James E. FitzGerald, Manager of Manufacturing, Brunswick International, Chicago, Illinois

61-MD-17 **Filament Wound Pressure Vessels,** by Richard Gorcey, Group Leader, Solid Propulsion Structural Components, Rocketdyne, A Division of North American Aviation Inc, Canoga Park, California

61-MD-18 **An Introduction to Designing with Plastics,** By R. L. Thorkildsen, Mechanical Behavior Engineer, General Engineering Laboratory, General Electric Company, Schenectady, New York, and Dr John V. Schmitz Manager-Chemical Research, Major Appliance Chemistry Laboratory, General Electric Company, Louisville, Kentucky

DYNAMICS—DAMPING AND GEARS

CO-CHAIRMAN: Dr Eric E.Unger, Senior Engineering Scientist, Bolt, Beranek and Newman Inc, Cambridge, Massachusetts

Albert Beam, Staff Engineer, Vinco Corporation, Detroit, Michigan

61-MD-19 **Visco-elastic Damping,** by D. Kent Hatch, Jr, Engineer, Production Engineering Group, Plastics Division, Engineering Department, and C. Howard Adams, Manager, Product Engineering, Monsanto Chemical Company, Springfield, Massachusetts

61-MD-20 **Effect of Misalignment on Tooth Action of Bevel and Hypoid Gears,** by Meriwether L. Baxter, Jr, Chief Research Engineer, Gleason Works, Rochester, New York

LUBRICATION—MOLYDISULFIDES AS AN ANSWER

CO-CHAIRMAN: Alfred Sonntag, President, The Alpha-Molykote Corporation, Stamford, Connecticut

Dr Stanley L. Cosgrove, Assistant Chief, Lubricants Chemistry, Battelle Memorial Institute, Columbus, Ohio

61-MD-21 **Molybdenum Disulfide as a Lubricant,** by Kenneth B. Wood, Jr, Manager, Chemical Division, Climax Molybdenum Company, A Division of American Metal Climax Inc, New York, New York

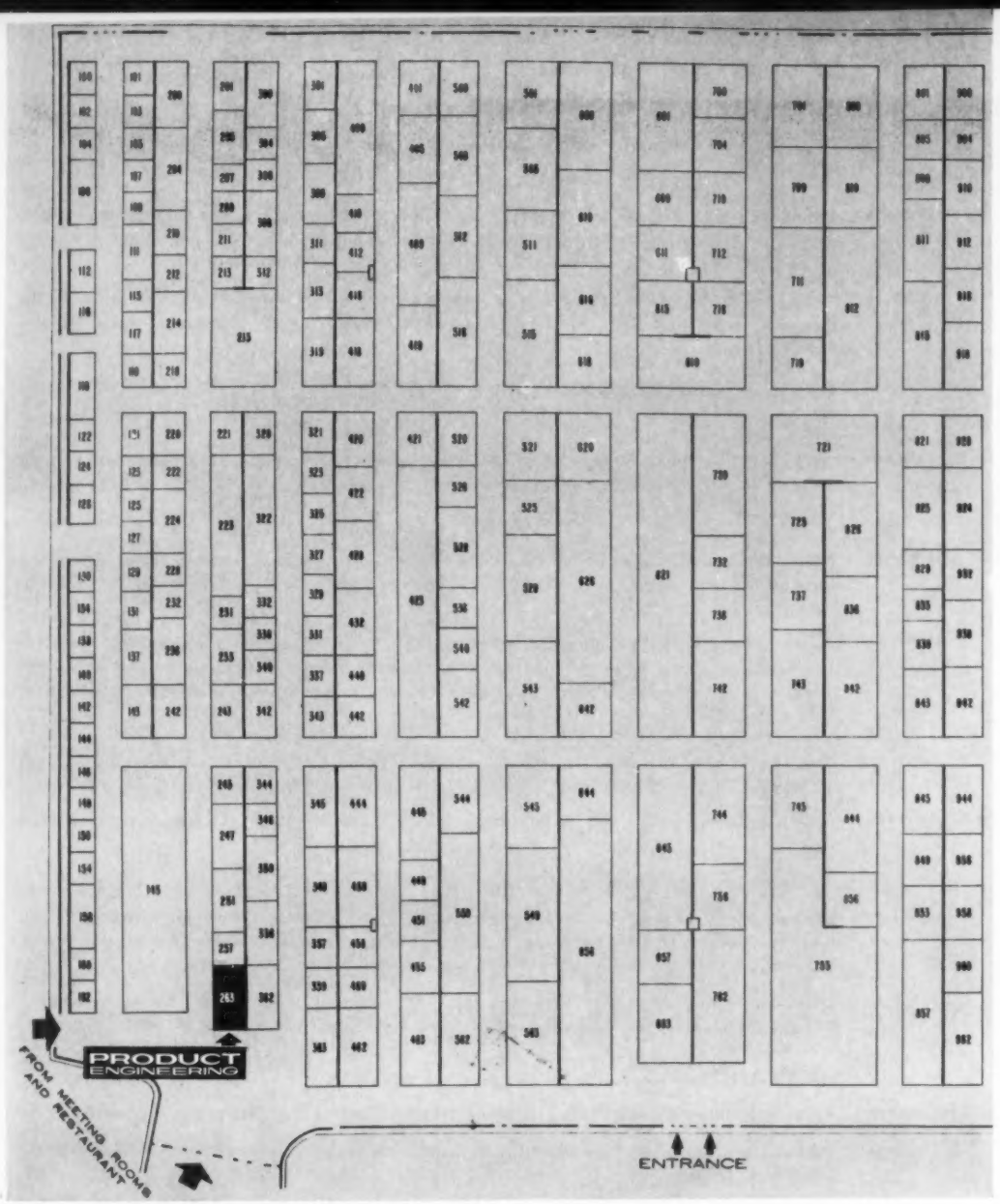
61-MD-22 **Molybdenum Disulfide as an Additive to Improve the Performance of an Automotive Multipurpose Grease,** by H. G. Rudolph, Jr, Automotive Division, Products Department, Socony Mobil Oil Company Inc, New York, New York

ASME Design Engineering Conference Papers

Conference papers will be bound into book form and given to all conference registrants. Additional copies will be available at the conference only for $10 per copy.

Pamphlet copies of numbered papers are obtainable from ASME Order Department, 29 West 39 Street, New York 18, NY. Please order by paper number. Papers are priced at 50¢ to members, $1 to nonmembers. Payment may be made by check, US postage stamps, free coupons distributed annually to the members, or coupons purchased from the Society. Coupons, in lots of ten, are $4 to members; $8 to nonmembers.

DESIGN SHOW FLOOR PLAN



WHO'S SHOWING WHAT...

ACF ELECTRONICS DIV, ACF INDUSTRIES, INC 1023
Electrical and electronic components

ACME CHAIN CORP..... 1004
Chain

ACME STEEL CO 301
Steel stitchers

THE ADAMS & WESTLAKE CO.... 201
Mercury plunger-type relays

AEROQUIP CO 619
Hose assemblies, fittings, and couplings

AETNA BALL AND ROLLER BEARING CO 213
Ball & roller bearings and chain idlers

AFCO FITTING CO, DIV OF THE UNITED STATES AIR COMPRESSOR CO 953

AIRCRAFT & MISSILES..... 349
Magazine

AIRMATIC VALVE, INC..... 1152
Valves & cylinders and pumps

AIR-MAZE CORP 160
Air filters, exhaust spark arrestors

THE LOUIS ALLIS CO..... 945
Various drives, motors

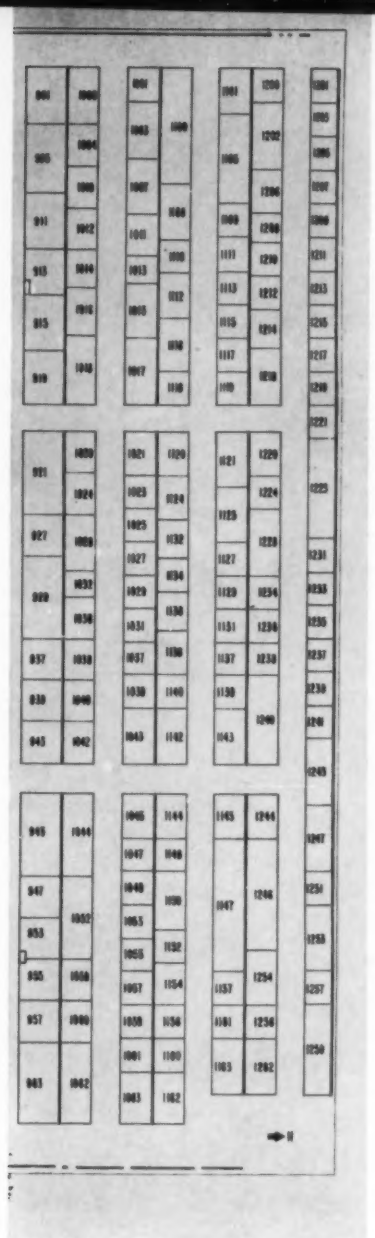
ALLOY CASTING INSTITUTE..... 329
Stainless castings

ALLOY PRODUCTS CORP..... 221
Tanks and formed shapes, metal fabricators

ALUMINUM CO OF AMERICA.... 721
Aluminum products

ALUMINUM EXTRUSIONS, INC.... 313
Aluminum extruded products

AMCO ENGINEERING CO..... 449



by exhibitor

AMERICAN KOYO CORP..... 1109
Mechanical components

AMERICAN MACHINE & METALS, INC 857
Fans, testing machines, filters

AMERICAN NICKELOID CO..... 1042
Prefinished & preplated metals

AMERICAN OPTICAL CO..... 1139
Fiber optics

AMERICAN SCREW CO..... 835
Fasteners, cold headed products

AMERICAN SEALANTS CO..... 131
Sealants for locking fasteners

AMERICAN SMELTING & REFINING CO 711
Continuous cast bronze

AMERICAN SOCIETY OF MECHANICAL ENGINEERS 1253
Technical literature

AMERICAN-STANDARD CONTROLS 257
Switches and spring mechanisms

AMERICAN STOCK GEAR DIV, PERFECTION GEAR CO..... 1212
Gears

AMERICAN ZINC INSTITUTE..... 712
Die casting and rolled zinc applications

AMPLEX DIV, CHRYSLER CORP.... 1142
Air bearings, liners for aluminum engine blocks, V-groove pulleys

ANACONDA METAL HOSE DIV, THE AMERICAN BRASS CO..... 312
Metal hose and flexible tubing assemblies

THE ANDERSON CO, ROTON PRODUCTS DIV 800
Mechanical components

ARCH INSTRUMENT CO, INC..... 1011
Gear checkers and other precision instruments

ARGUTO OILLESS BEARING CO.. 210
Bearings and pulleys

ARMCO STEEL CORP..... 409
Steel shapes and forms

ASSOCIATED SPRING CORP..... 445
Springs, metal stampings, metal fabricators

ATLAS CHAIN & MANUFACTURING CO 505
Precision gears, electro-mechanical assemblies, differentials

THE AUBURN MANUFACTURING CO 540
High-temperature conductive and shielding gasket materials

AUTOMATIC SWITCH CO..... 825
Valves and switches

AUTOMOTIVE INDUSTRIES 349
Magazine

AUTOMOTIVE RUBBER CO, INC.. 932
Rubber products

AVERY LABEL CO, A DIV OF AVERY ADHESIVE PRODUCTS, INC.... 905
Mylar-covered printed nameplates and labels, pressure-sensitive metalized panels and nameplates

AVISUN CORP 419
Polypropylene products

B-MOLD DIV, BUCKEYE BRASS & MFG CO 1032
Ferrous and non ferrous investment and steel die permanent mold castings

BARRY CONTROLS INC..... 904
Shock and vibration isolators, mounts for sensitive equipment

BATTELLE MEMORIAL INSTITUTE.. 236
Research and development service

BEAVER PRECISION PRODUCTS, INC 410
Ball screw assemblies, ball splines, ball-way cartridge

BENDIX COMPUTER DIV, THE BENDIX CORP 1147

BENDIX FOUNDRIES, THE BENDIX CORP 1146

THE BERYLLIUM CORP..... 520
Beryllium-copper alloys and products

BINKS MANUFACTURING CO.... 519
Spray gun for plural component materials

BOSTON GEAR WORKS..... 342
Helical-geared motorized speed reducers

W H BRADY CO..... 321
Nameplates, anodized aluminum nameplates; wire and cable markers, marking machines, printed circuit tapes and shapes

BRIDGEPORT THERMOSTAT DIV, ROBERTSHAW - FULTON CONTROLS CO 223
Welded bellows, temperature sensors, air volume controls, pump switches, pressure relief valves

THE BRISTOL CO..... 1036
Socket screws

BROOK MOTOR CORP..... 1121
Motors

BROWNING MANUFACTURING CO 251
V-drives, variable speed drives, chain drives, couplings, pillow blocks

THE BRUSH BERYLLIUM CO..... 657
Beryllium metal alloys and compounds

BUCHANAN ELECTRICAL PRODUCTS CORP 720
Pneumatic crimping tools, terminal blocks

BURLING INSTRUMENT CO..... 124
Temperature controls, thermostats, temperature alarms

CANADA, THE DEPARTMENT OF TRADE AND COMMERCE 145
Engineering services

CARLOCK INC 618
Engineering components

CARR FASTENER CO, DIV UNITED-CARR FASTENER 1242
Plug buttons, fasteners, wiring clips

continued on page 120

1961 DESIGN SHOW

WHO'S SHOWING WHAT . . . by exhibitor

CARTER CONTROLS, INC..... 1005
Switches

CASTING ENGINEERS DIV, CONSOLIDATED FOUNDRIES AND MFG CORP 460
Investment castings, thin-walled stainless steel castings

CELANESE PLASTICS CO, DIV OF CELANESE CORP OF AMERICA. 645
Engineering services

CENTURY ELECTRIC CO..... 921
Electrical components

CHAIN BELT CO..... 929
Self-aligning roller bearings, power transmission equipment and roller chain

CHART-PAK INC 458
Pressure-sensitive tapes and charts

CHEMIQUIP CO 1200
Pressure snubbers

CHEMO PRODUCTS, INC..... 332
Engineering services

CHERRY ELECTRICAL PRODUCTS CORP 1118
Switches

CHICAGO-ALLIS MANUFACTURING CORP 154
Face-type seals, packings, belts, diaphragms, bellows, pistons

CHICAGO RIVET AND MACHINE CO 1218
Fasteners

CHILTON CO 349
Magazines

CHRYSLER CORP, AMPLEX DIV.... 1142
Self-lubricating bearings, powder metal parts

CIRCLE F MFG CO..... 422
Lamp holders and outlets

CLAD-REX DIV OF SIMONIZ CO.. 309
Vinyl-clad metals

CLEVELAND GRAPHITE BRONZE DIV OF CLEVITE CORP..... 121
Sleeve bearings, bushings, thrust washers, shaft seals

CLEVELAND MACHINE CONTROLS CORP 336
Switches

CLIMAX MOLYBDENUM CO, DIV OF AMERICAN METAL CLIMAX CO 511
Molybdenum alloys

CLIPPARD INSTRUMENT LABORATORY INC 1013
Bore cylinder, sequence programer

COATING PRODUCTS INC..... 938
Mylar materials

COBEHN, INC 102
Spray equipment and solvents

COLONIAL RUBBER CO..... 919
Industrial rubber, plastic, ceramic products

COLUMBUS COATED FABRICS CORP 525
Vinyl-clad metal

COLUMBUS ELECTRIC MANUFACTURING CO 1055
Precision snap-action switches, miniature snap-action switches, rotary switches

COMBINATION PUMP VALVE CO. 805
Valves and fittings

COMMERCIAL FILTERS CORP..... 214
Metallic and nonmetallic liquid and gas filters, magnetic separators

CONGRESS DRIVES DIV, TANN CORP 924
Pulleys, V-belts

CONNEAUT RUBBER & PLASTICS CO 919
Industrial rubber, plastic, ceramic products

CONTINENTAL-DIAMOND FIBRE CORP 156
Laminated plastics

CONTROLEX CORP OF AMERICA.. 122
Ball bearing flexible remote controls

COORS PORCELAIN CO..... 1262
High alumina and beryllia ceramics

COPPER & BRASS RESEARCH ASSOC 528
Nonferrous parts, shapes, forms

CORBIN CABINET LOCK DIV..... 1223
Aluminum and bronze cup and drop handles, locking devices, catches, handles and pulls

CRANE PACKING CO..... 237
Hydraulic packings and seals

CRAWFORD FITTING CO..... 1108
Tubing

CULLMAN WHEEL CO..... 1144
Sprockets, chains, flexible couplings

CURTISS-WRIGHT CORP, MARQUETTE DIV 1219
Metals and alloys

CYCLEDYNAMICS, INC 1206
Power transmission equipment

THE D.S.D. MANUFACTURING CO 222
Metallic O-rings, quick-disconnect clamps, gaskets, seals

DAYTON INDUSTRIAL PRODUCTS CO, DIV OF DAYCO CORP.... 1017
Molded products of rubber, rubber-to-metal, rubber-to-fabric

THE DECATUR CASTING CO..... 955
Castings

DE LAVAL STEAM TURBINE..... 836
Pumps, compressors, gear drives

DELUXE COILS INC..... 1116
Electrical and electronic products, plastic products

DENNISON ENGINEERING DIV, AMERICAN BRAKE SHOE CO... 611
Servo valves and pumps

DESIGN NEWS 756
Magazine

DETROIT CONTROLS DIV AMERICAN RADIATOR & STANDARD SANITARY CORP 257
Multiple-liquid dispensers, miniature switches, thermostatic actuators

DIAMOND CHAIN CO..... 1228
Flexible chain

DISOGRIN INDUSTRIES 1235
Synthetic rubber products

DIXON CORP 146
Shapes and fabricated parts

DIXON SINTALOY INC..... 1059
Powder-metal gears, inserts, die-castings, molded nylon parts

THE DOBECKMUN CO OF THE DOW CHEMICAL CO 745
Metallized films and lamination

DODGE MANUFACTURING CORP.. 322
Couplings, drives, pillow blocks, speed reducers and roller chain

DOW CORNING CORP..... 644
Silicone paint, molding and laminating resins, dielectric materials, rubber, fluids

DROP FORGING ASSOC..... 204
Engineering services

DUFF-NORTON CO 401
Worm-gear jacks

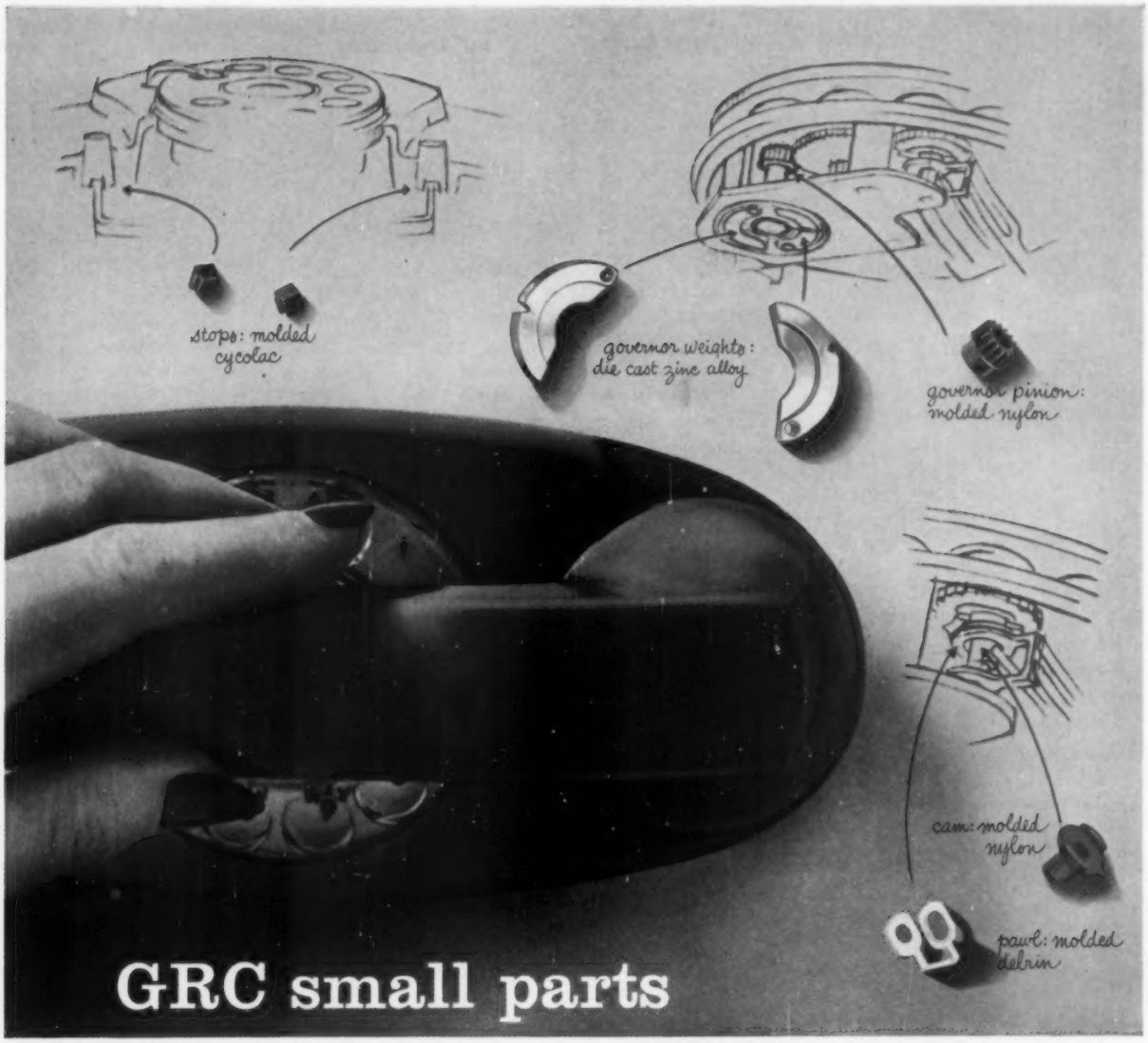
E. I. DU PONT DE NEMOURS & CO 761
Film materials

E. I. DU PONT DE NEMOURS & CO, FILM DEPT 860
Cellulose sponges, polyester film, acetate films

E. I. DU PONT DE NEMOURS & CO, ORCHEM DEPT 755
Fluorinated hydrocarbon refrigerants, propellants, solvents

continued on page 122

all parts and Western Electric's "Princess" Telephone shown actual size



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MAXIMUM SIZES / Zinc alloy – 2", ½ oz. / Plastics – 1¾", .03 oz.

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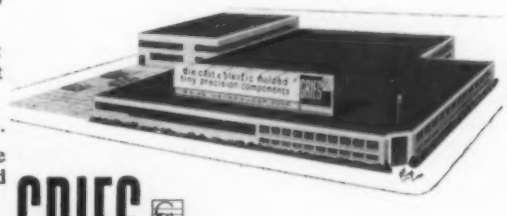

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CIRCLE 121 ON READER SERVICE CARD 121

1961 DESIGN SHOW

WHO'S SHOWING WHAT . . . by exhibitor

E. I. DU PONT DE NEMOURS & CO, POLYCHEM DEPT 763
Plastic resins

DURAKOOL INC 442
Mercury relays, contractors, switches, metal-to-glass seals, coils, transformers

DURTRON CO, INC, MODERN INDUSTRIAL PLASTICS DIV..... 1236
Plastic components

DYNAMIC GEAR CO INC..... 134
Miniature, precision, stock and custom gears and differentials, miniature transmission and speed reducers

DZUS FASTENER CO INC..... 428
Standard and specialty fasteners

ETC INC 1157
Electronic components

EAGLE SIGNAL CORP..... 1014
Controls

EASTMAN CHEMICAL PRODUCTS, INC 719
Injection-molded, extruded and vacuum-formed plastic parts

EASTMAN CHEMICAL PRODUCTS, INC, PLASTICS DIV..... 812
Plastic resins

EATON MANUFACTURING CO.... 656
Worm gears, speed reducers, industrial fasteners variable speed drives

EBERT ELECTRONICS CORP..... 1119
Relays and controls

ECLIPSE MACHINE DIV, THE BENDIX CORP. 1147
Fuel pumps, brakes, motor starter drives, switches

ELASTIC STOP NUT CORP OF AMERICA 720
Self-locking fasteners

ELECTRIC BOAT DIV, GENERAL DYNAMICS CORP..... 709
Drives & controls, submarine simulator, oxygen generator, ball valve, vaneaxial fan

ELECTRO DYNAMIC DIV OF GENERAL DYNAMICS CORP..... 709
Controls

ELECTRO-FLEX HEAT, INC..... 112
Temperature controls, electric flexible heaters

ELECTRO-MECHANICAL INSTRUMENT CO..... 1148
Engineering instrumentation

ELECTRO-TECHNOLOGY 320
Publication

ELIZABETH DIV, ELASTIC STOP NUT CORP OF AMERICA..... 720
Standard and specialty fasteners

ENCYCLOPEDIA BRITANNICA, INC 1207
Encyclopedia Britannica, Senior
Encyclopedia Britannica, Junior

ENFAB, INC..... 232
Non-metallic materials

ENJAY CHEMICAL CO, DIV OF HUMBLE OIL & REFINING CO.. 600
Plastic parts

ERIEZ MANUFACTURING CO..... 245
Magnetic vibratory feeders, vibrators, magnetic separators

FAC DIV, OVERSEAS COMMODEX, INC 123
Engineering kits

FAIRCHILD PUBLICATIONS, INC... 1109
Magazines

FALSTROM CO..... 821
Welding torch and rack cabinets

FASSON PRODUCTS, DIV OF AVERY ADHESIVE PRODUCTS, INC..... 416
Fasteners

FAULTLESS CASTER CORP..... 1038
Polyurethane caster wheels

FAWICK AIRFLEX DIV, FAWICK CORP 224
Cool brakes, clutches and brakes

FENWAL INC..... 460
Differential expansion thermoswitch thermostat controls and Epoxy handling systems

THE FERRY CAP & SET SCREW CO 809
Fasteners, cap screws and set screws

FIBERFIL, INC..... 1101
Fiberglass reinforced materials

FLEXIBLE CONTROLS CORP..... 1140
Switches and relays

THE FLODAR CORP..... 311
Tube fittings

FLORIDA DEVELOPMENT COMMISSION 1150
Engineering services

FOOTE BROS GEAR AND MACHINE CORP 444
Helical gear, worm gear, shaft mounted reducers

FORMSPRAG CO..... 736
Power transmission products

FRANKLIN ELECTRIC CO..... 1052
Motors

H B FULLER CO..... 1129
Assemblies using adhesives, plastic alloys, sealants and coatings

GENERAL BEARING CO INC..... 1132
Bearings

GENERAL CONTROLS CO..... 1024
Solenoid valves, counters, switches, controls, electronic components

GENERAL ELECTRIC CO..... 423
Limit and drum switches, push buttons, motors and drives

THE GENERAL FIREPROOFING CO 942
Engineering furniture

GENERAL MOTORS RESEARCH LABORATORIES 704
Testing machines

GLASS LABORATORIES INC..... 148
Plastic mouldings

GLEASON REEL CORP..... 1015
Cable reels and hose reels

GLEASON WORKS..... 500
Engineering services in the area of angular transmission applications

B F GOODRICH AVIATION PRODUCTS, DIV OF B F GOODRICH CO 420
Rivnuts and installation tools

GRAY IRON FOUNDERS' SOC INC 305
Castings

GREENE, TWEED & CO..... 105
Seals, V-packings, U-rings

GRIES REPRODUCER CORP..... 1143
Die casting and plastic molding techniques

GROOV-PIN CORP..... 1221
Thread-forming inserts and drive studs, self-tapping inserts

H P L JERSEY CO..... 911
Shapes and forms

HPL MANUFACTURING CO..... 911
Stampings

HAMILTON FOUNDRY INC..... 744
Foundry products

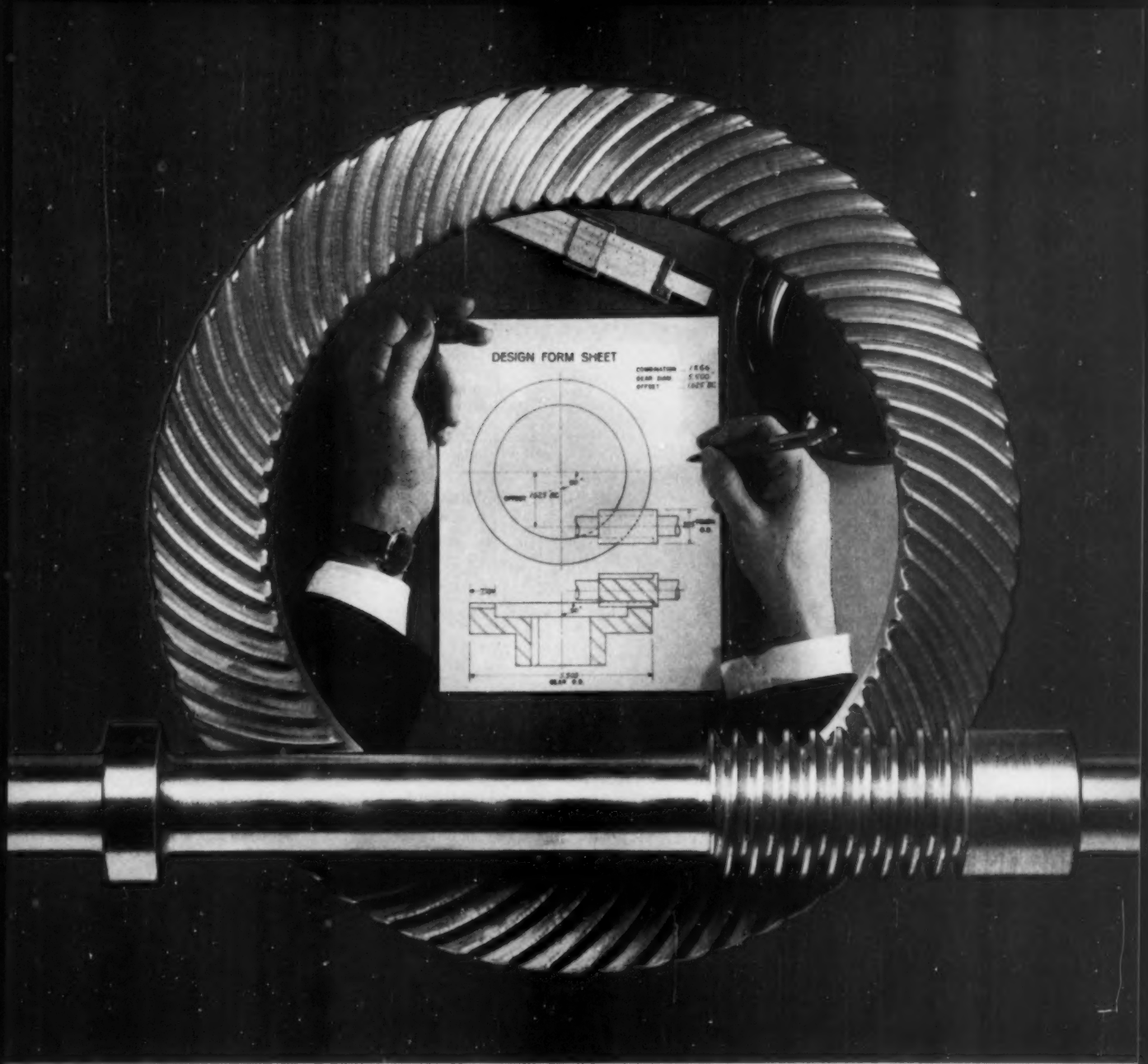
HAMILTON MANUFACTURING CO 620
Castings, drafting tables, filing systems and files

HANDY & HARMAN..... 516
Brazing alloys and fluxes

THE HANSEN MANUFACTURING CO 512
Quick-connect fluid couplings

HART REDUCTION PULLEY CO.... 109
Reduction pulleys

continued on page 126



Why it will pay to design your high reduction gearing with Gleason HRH*

If you want to make your transmission more quiet or more compact or more flexible, take a good long look at the HRH set shown above.

This single set of gears gives a reduction of 66 to 1.

The action is quiet and smooth and continuous because the pinion teeth *wrap around* the gear teeth. With this design you can work such quiet operation into your designs even with a one- or two-tooth pinion member.

You can add the rigid support of a straddle mounting, since bearings can be put on both ends of the pinion.

HRH gear ratios are made with proven face mill cutting techniques, assuring complete control of tooth contact pattern to compensate for any assembly or operating condition.

HRH gear ratios are designed with the *full* assistance of all Gleason engineering services. We work with you on the practical design aspects and carry through to the development of prototypes. Then we furnish both machines and tooling for full production—*without royalties.*

Find out what HRH gearing can do for your transmissions. Send for our design form sheet and then send us the gear ratios and sizes you want. We'll send back detailed recommendations promptly.

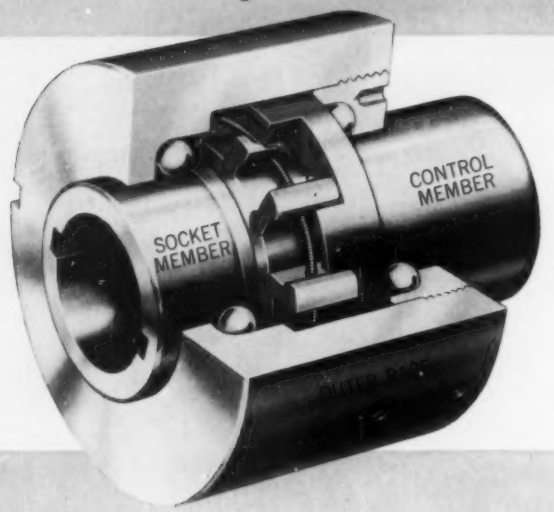
*Trademark for Gleason High Reduction Hypoids

GLEASON WORKS

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

CIRCLE 123 ON READER SERVICE CARD

NOW! a positive positioning device that stops feedback torque without backlash . . .



Rev-Lok devices can efficiently perform a number of application functions such as two-directional drive, positioning, over-running, backstopping, prevention of feedback, etc. Generally, the mounting arrangement used determines which functions are obtained. However, to provide specific details on how Rev-Lok components operate to perform individual functions, sketches and description relating to several typical applications are provided on the facing page.

Now! For any application requiring a power transmission device, that will drive in both directions and instantly stop all feedback torque, the REV-LOK design offers precision performance characteristics and safety factors previously unobtainable in so compact a product.

REV-LOK features a complement of sprags arranged in opposing pairs to automatically and instantly stop feedback in both directions of rotation . . . there is no backlash on output shaft. Also, the design concept provides multi-contact surfaces for greater driving and holding torque, assures equalized radial loading of REV-LOK devices, and evenly distributes wear over all sprags and entire race surface to secure longer life.

The functional versatility of the REV-LOK device is evidenced in its successful use on many diverse applications. Depending on the mounting arrangement employed, REV-LOK devices can be used for: two-directional drive and positive positioning, two-way over-running or backstopping, dual drive or single revolution applications, anti-shock steering, torque limiting, etc.

REV-LOK devices have greater torque capacity for their size and weight, and permit higher over-running speeds than any similar product. Current catalog models are available in torque ratings from 90 lbs. in. to 30,000 lbs. in. and with bore diameters ranging from ¼" to 2½". Send for your free REV-LOK catalog—it provides further operational and technical details.

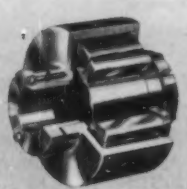
Be Sure To Visit Booth 736 At The Design Show

FORMSPRAG COMPANY

23607 Hoover Road, Dept. 115, Warren (Detroit), Michigan

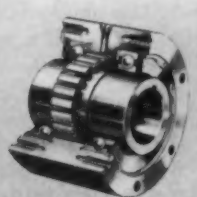
Representation Throughout The World • Precision Power Transmission Products

OTHER FORMSPRAG® PRODUCTS

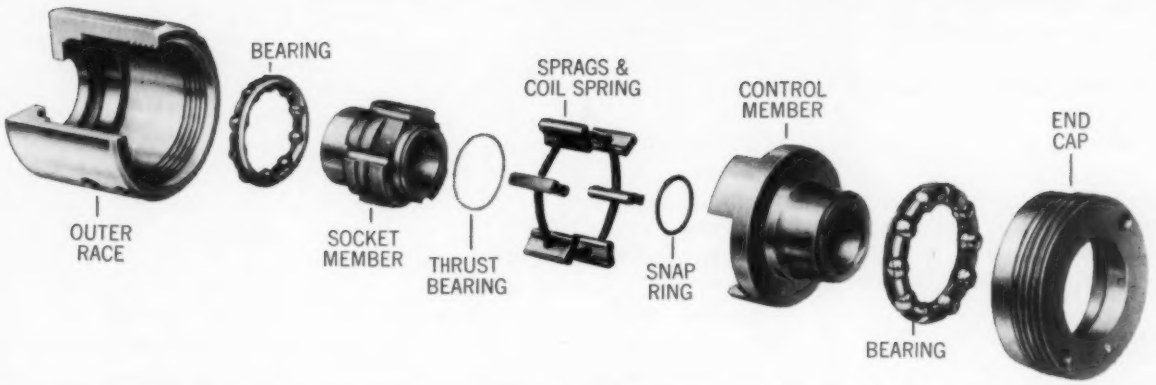


Rawson® Centrifugal Clutches for no-load motor starts and cushioned starting of loads.

Formsprag® Clutches for every over-running, indexing and backstopping application.



...this is REV-LOK



HERE'S HOW REV-LOK DEVICES FUNCTION

With the OUTER RACE held in a stationary or fixed position, torque is transmitted as follows: (Figure 1) The CONTROL MEMBER projects between each pair of opposing sprags and when driving torque is applied to it, each projection first contacts a sprag at point "A" to disengage the sprag from the OUTER RACE. Then, the CONTROL MEMBER drives against the sprag at point "B" to transmit driving torque directly to the SOCKET MEMBER. (Figure 2) When input torque is reversed, the CONTROL MEMBER rotates a maximum of 3° to release the opposing set of sprags and then again drives the SOCKET MEMBER through point "B" on these sprags. (Figure 3) Any input torque from the SOCKET MEMBER is instantly stopped by the wedging of sprags between the fixed OUTER RACE and the SOCKET MEMBER—feedback torque never reaches the CONTROL MEMBER.

(Figure 4) When the SOCKET MEMBER is held stationary and the CONTROL MEMBER is held in a neutral position between the sprags, any input torque applied to the OUTER RACE is instantly stopped by the wedging of the sprags between OUTER RACE and fixed SOCKET MEMBER. However, by applying a relative torque to the CONTROL MEMBER in one direction (Figure 5), the OUTER RACE can over-run in the opposite direction and will also be backstopped. To reverse the direction of OUTER RACE over-running and backstopping, the torque applied to the CONTROL MEMBER is reversed.

(Figure 6) If the CONTROL MEMBER is held in a fixed position and the SOCKET MEMBER is allowed to float freely on a shaft, the OUTER RACE will over-run in either direction. However, if a torque is applied to the SOCKET MEMBER, the OUTER RACE will only over-run in the direction that the torque is applied and will backstop in the opposite direction.

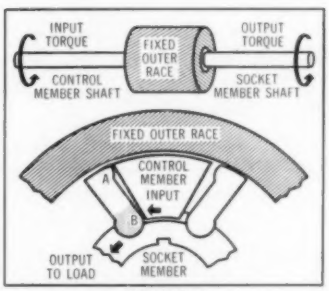


FIGURE 1

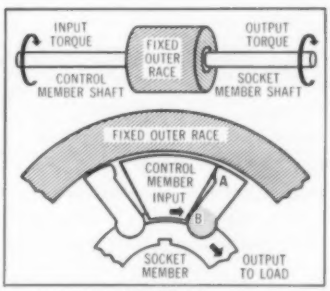


FIGURE 2

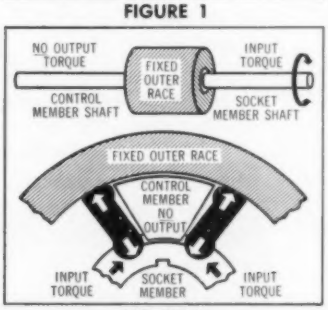


FIGURE 3

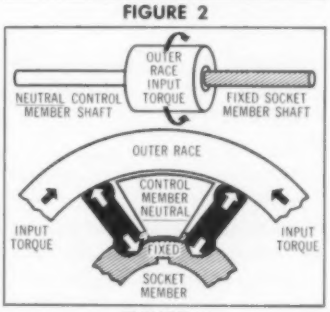


FIGURE 4

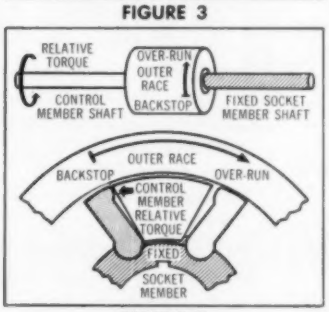


FIGURE 5

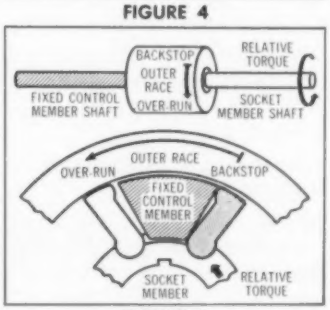


FIGURE 6

CIRCLE 125 ON READER SERVICE CARD

WHO'S SHOWING WHAT . . . by exhibitor

HARTFORD STEEL BALL CO..... 1205
Bearings, ball retainers, wheel bearings

THE HARTWELL CORP..... 915
Fasteners

JOHN HASSALL, INC..... 927
Cold headed parts

HAYDON DIV OF GENERAL TIME CORP 853
Timers and timing motors

HAYNES STELLITE CO, DIV UNION CARBIDE 621
Metals, ceramics, powders, investment castings

THE HEIM CO..... 843
Bearings, bearing rod ends

HEINEMANN ELECTRIC CO..... 1247
Circuit breakers and relays

HELI-COIL CORP..... 1043
Wire thread inserts and inserting tools

HEXCEL PRODUCTS INC..... 1053
Mechanical components

HEYMAN MANUFACTURING CO.. 218
Heyco bushings and hole plugs

THE HILLIARD CORP..... 1120
Single revolution clutches, over-running clutches, slip clutches and clutch couplings, intermittent drive unit

HITCHCOCK PUBLISHING CO..... 1137
Magazines

HITCHINER MANUFACTURING CO, INC 1025
Precision castings

HOKE INC..... 455
Pressure switches, gauge protectors, pressure regulators, and valves

HOOVER BALL AND BEARING CO 1062
Ball bearings, pillow blocks, cylindrical and spherical roller bearings

E F HOUGHTON & CO..... 920
Packing materials

HUMPHREY PRODUCTS DIV, GENERAL GAS LIGHT CO..... 1154
Gas heaters

HUNGERFORD PLASTICS CORP... 610
Molded plastics

HUNTER SPRING CO, AMERICAN MACHINE & METALS INC..... 857
Extension spring and spring motor

HYDRAULICS & PNEUMATICS.... 1040
Magazine

ILLINOIS TOOL WORKS..... 844
Specialty fasteners

IMPERIAL-EASTMAN CORP..... 956
Hydraulic and pneumatic components

INDUSTRIAL EQUIPMENT NEWS.. 1239
Magazines

THE INDUSTRIAL PRESS..... 1209
Publications

THE INDUSTRIAL PUBLISHING CORP 1040
Magazines

INDUSTRIAL TECTONICS, INC.... 1000
Ball and roller bearings

INSTRUMENT SPECIALTIES CO, INC 343
Beryllium-copper products

THE INTERNATIONAL NICKEL CO, INC 529
Nickel and nickel alloys, finishes, coatings

INTERNATIONAL PACKINGS CORP 742
Oil seals, packings, O-rings, precision molded parts

THE IRON AGE..... 349
Magazine

JANETTE ELECTRIC MFG CO..... 101
Gearmotors, variable speed control equipment, valve drives

JANNEY CYLINDER CO..... 1163
Centrifugally cast parts from ferrous and non-ferrous alloys

JOHNSON BRONZE CO..... 1012
Sleeve bearings

JONES & LAUGHLIN STEEL CORP, STAINLESS AND STRIP DIV.... 737
Stainless sheet, strip, bar, wire, zinc and copper-coated steel

THE JOYCE-CRIDLAND CO..... 1110
Worm gear jacks, hydraulic cylinders

THE KAYDON ENGINEERING CORP 137
Bearings

KAYNAR MANUFACTURING CO.. 1010
Fasteners and adhesives

KENNAMETAL INC..... 562
Tungsten and tungsten-based carbides, tantalum, manufactured parts

LAMINATED SHIM CO, INC..... 116
Shims, stampings, washers, metallic gaskets, rocker arms and conversions

THE LAMSON & SESSIONS CO.... 140
Standard and specialty fasteners

LANCASTER GLASS CORP..... 304
Custom glass parts

LANDIS & GYR, INC..... 1160
Electrical impulse and pre-selection counters, miniature ball and roller bearings

LA SALLE STEEL CO..... 563
Alloy steel bars

LEAD INDUSTRIES..... 111
Nonferrous parts, shapes, forms

LEHIGH CHEMICAL CO..... 1253
Lubricants, oils

LEIMAN BROS, INC..... 129
Integral pump and motor unit

LICON DIV, ILLINOIS TOOL WORKS 844
Precision snap-acting switches

LIGNUM-VITEE PRODUCTS CORP.. 144
Conveyor hanger bearings

LINEMASTER SWITCH CORP..... 1145
Electric foot switches

LINK-BELT CO..... 743
Power transmission equipment, variable speed drives

LISLE CORP..... 1224
Magnetic plugs, hydraulic brake parts

LORD MANUFACTURING CO..... 912
Vibration, shock and noise control mountings and mounting systems

LOVEJOY FLEXIBLE COUPLING CO 1044
Universal joints

MACHINE DESIGN..... 363
Magazine

MACLEAN-FOGG LOCK NUT CO 242
Lock nuts, bolts

MAGNESIUM PRODUCTS OF MILWAUKEE INC..... 1015
Magnesium components

THE MALAYAN TIN BUREAU..... 1047
Engineering services

MALLEABLE CASTING COUNCIL.. 700
Malleable castings

MALLEABLE FOUNDERS SOCIETY.. 700
Malleable castings

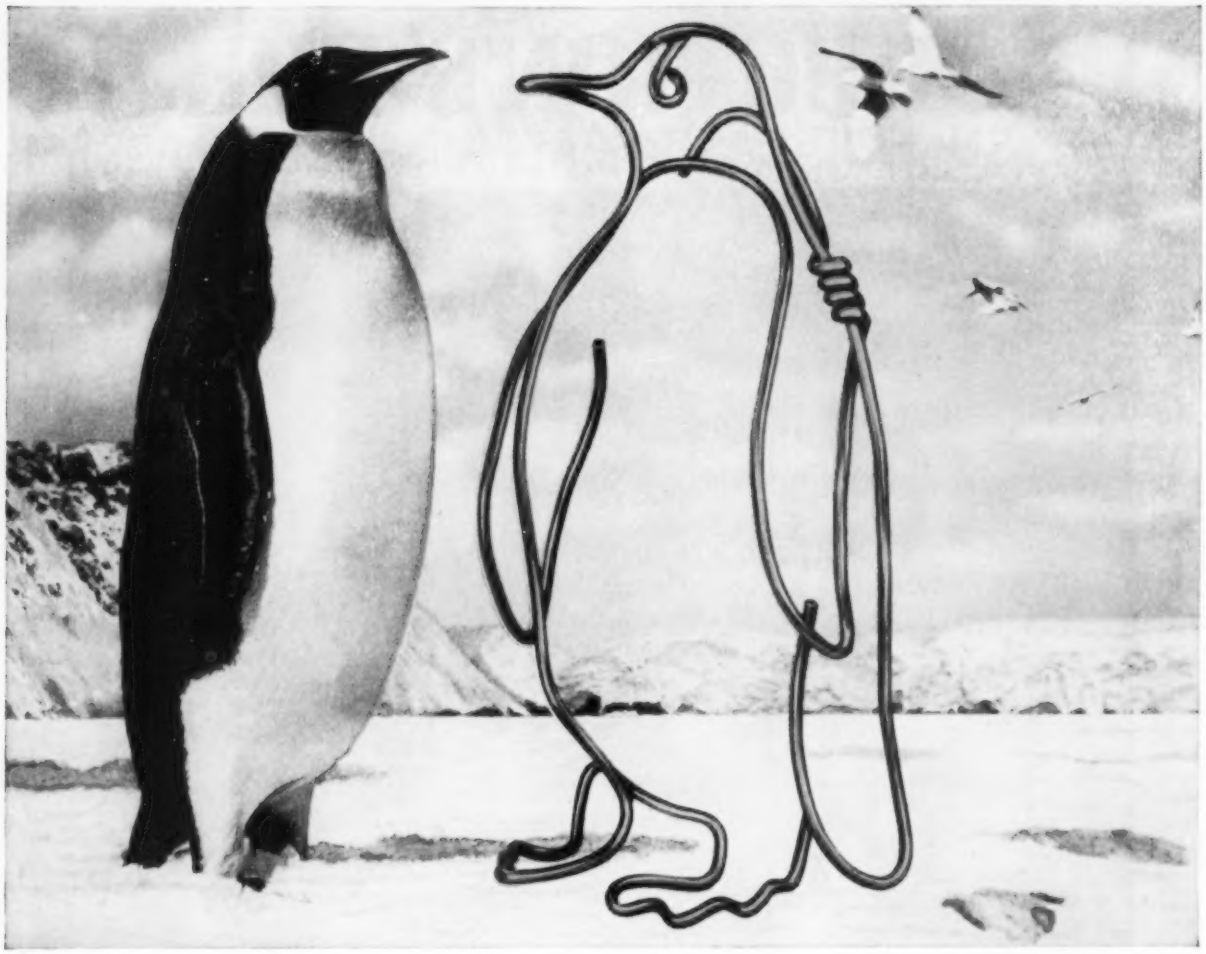
MANHEIM MFG. & BELTING CO.. 1241
U-belting, variable speed belts

MARBON CHEMICAL DIV, BORG-WARNER CORP..... 725
Polymers

MARLANE DEVELOPMENT CO, INC 306
Finishes, coatings, engineering services

MARTIN ENGINEERING CO..... 138
Vibrators

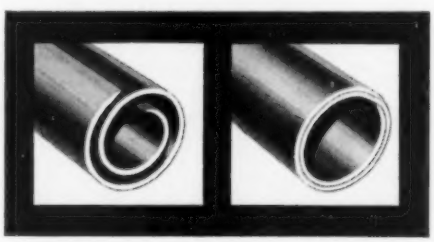
continued on page 130



Bundy can mass-fabricate practically anything

You design it. We'll find a way to mass-fabricate it . . . by the millions if needed. Our engineers will work with you at any time. They can often help you find cost-saving solutions to difficult tubing problems by using Bundyweld® steel tubing. For example, Bundyweld can be bent to close tolerances, flanged, upset, expanded, swaged, beaded or special formed. Standard wall diameter and O.D. are held to +.002″ to −.003″. Bundyweld meets ASTM 254; Govt. Spec. MIL-T-3520, Type III. For help, call or write: Bundy Tubing Company, Detroit 14, Michigan.

* * *



Bundyweld, double-walled from a single copper-plated steel strip, is metallurgically bonded through 360° of wall contact. It is lightweight, uniformly smooth and easily fabricated . . . has remarkably high bursting and fatigue strengths. Sizes up to ⅝″ O.D.

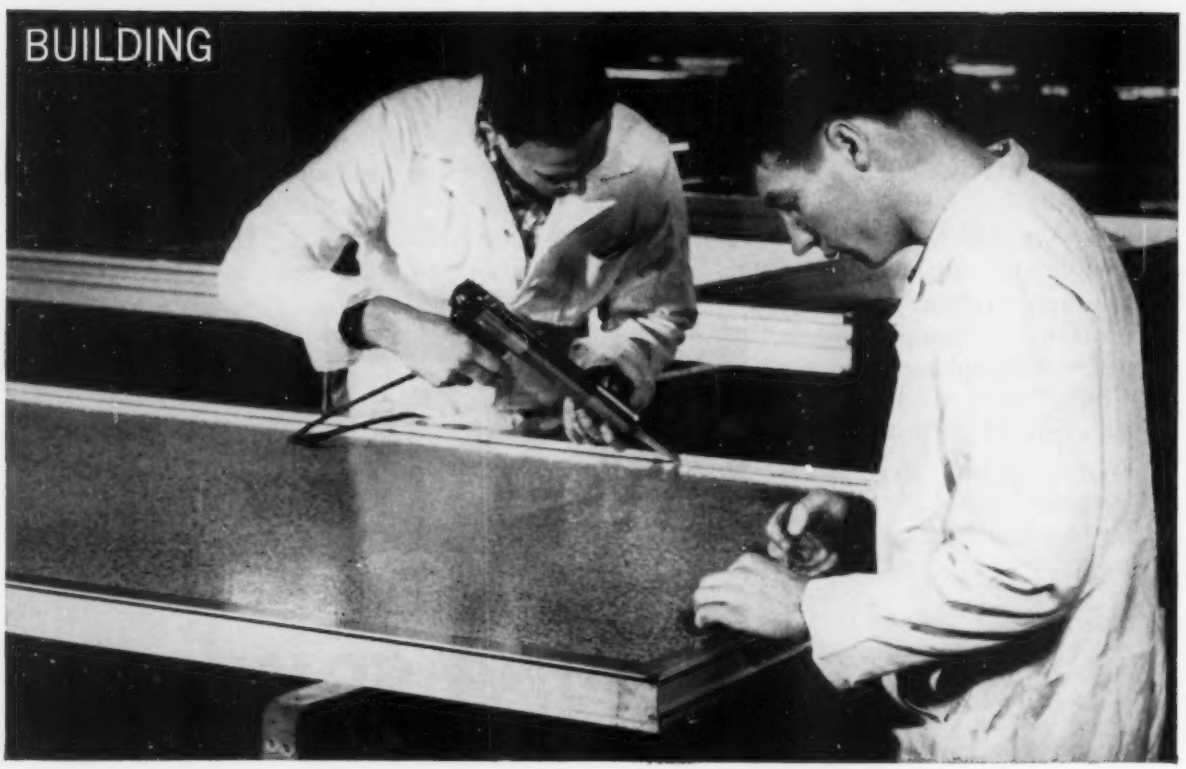
BUNDY® TUBING COMPANY

DETROIT 14, MICH. • WINCHESTER, KY. • HOMETOWN, PA.

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, ITALY, JAPAN.

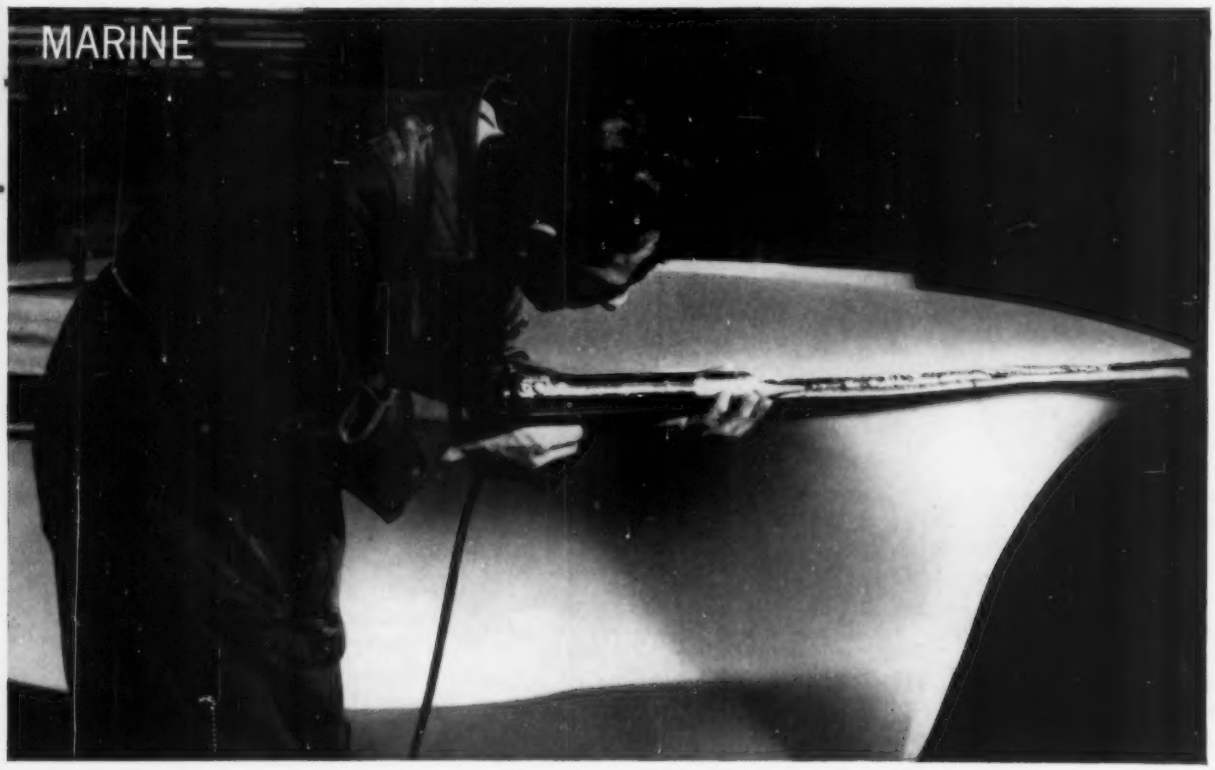
PRODUCTION'S BIG PLUS

POLYSULFIDE-BASE SEALANT SPEEDS ASSEMBLY



IN THE BIG INDUSTRIES

LINE PROCESSES, IMPROVES END PRODUCTS!



Compound with THIOKOL polysulfide polymer is being used in more and more products – as a sealant and adhesive – to seal joints and seams, to weatherproof, and to reduce or supplement mechanical fastening. ■ Leading trailer makers install it to bond roof to cross members, to seal floor joints and skylights. Top boat builders caulk decks and hulls with this material to produce pleasure craft that are lastingly watertight. Building components manufacturers weather-seal pre-fab curtain wall panels. The aircraft industry depends on it to seal integral wing fuel tanks. ■ THIOKOL polysulfide polymer is synthetic rubber in liquid form which air-cures to a flexible, cushiony solid. It adheres with weld-like strength to all kinds of materials – wood, metal, plastic, glass... resists oil, moisture, aging, gases, and thermal change... provides long life and trouble-free service. ■ A little imagination plus compounds with THIOKOL polysulfide polymer may improve your product, speed production, cut costs. It has for many industries. Full story? Write for Brochure IA-200.

Thiokol®
CHEMICAL CORPORATION
780 N. Clinton Ave., Trenton 7, N. J.
In Canada: Naugatuck Chemicals Division, Dominion Rubber Company, Elmira, Ontario

CIRCLE 129 ON READER SERVICE CARD 129

1961 DESIGN SHOW

WHO'S SHOWING WHAT . . . by exhibitor

THE MASLAND DURALEATHER CO 944
Vinyl surfacing for lamination to metals & hardboards

MATERIALS IN DESIGN ENGINEERING 963
Magazine

MAUREY MANUFACTURING CORP 346
Sprockets, chain, belts, pulley

MAYLINE CO, INC..... 732
Drafting tables

MAYSTEEL PRODUCTS INC..... 1015
Cable reels and hose reels

MCGILL MANUFACTURING CO... 1031
Bearings and switches

MCLOUTH STEEL CORP..... 810
Steel products

MEAD FLUID DYNAMICS, A DIV OF MEAD SPECIALTIES CO..... 839
Hydraulic cylinders, and flow regulating valves

MEAD SPECIALTIES CO..... 839
Hydraulic cylinders and flow regulating valves

MELRAY MANUFACTURING CO... 911
Engineering components

METAL POWDER INDUSTRIES FEDERATION 826
Metal powders, powder metal products

METAL & THERMIT CORP..... 1049
Metals and alloys, organic coatings, thermit welding

METALS & CONTROLS INC, CORPORATE DIV OF TEXAS INSTRUMENTS INC..... 1201
Switches

METALWORKING NEWS 1109
Publications

MICRO SWITCH 1211
Switches

MILLER ELECTRIC CO..... 300
Insulated electric wire, electric cord sets, line cords, connectors, encapsulated components and retractile coiled cords

MINNEAPOLIS-HONEYWELL REGULATOR CO..... 121
Switches

MINNESOTA MINING AND MANUFACTURING CO..... 550
Adhesives

MO-BAR HYDRAULIC SALES CO.... 829
Hydraulic cylinders, boosters and accumulators

MOELLER MANUFACTURING CO, INC 1257
Adjustable mechanical expansion closures and stoppers

MONO-RACE DIV, THE THEW SHOVEL CO 416
Mechanical components

MORSE CHAIN CO..... 842
Chain, sprockets, couplings, clutches, speed reducers

MOTT METALLURGICAL CORP.... 1115
Metals

MUELLER BRASS CO..... 701
Brass and copper parts and products

MYCALEX CORP OF AMERICA.... 1063
Insulation materials

NATIONAL BERYLLIA CORP..... 1134
Custom and standard beryllium oxide ceramic shapes

NATIONAL CARBON CO..... 621
Engineered products

NATIONAL LEAD CO..... 545
Lead components

NATIONAL REPRODUCTION CO.. 207
Stampings

NATIONAL-STANDARD CO..... 801
Wire

NATIONAL TUBE DIV, UNITED STATES STEEL..... 626
Mechanical parts, power transmission devices, shapes and forms

NATIONAL VULCANIZED FIBRE CO 421
Laminated plastics

NEW DEPARTURE DIV, GENERAL MOTORS CORP..... 118
Bearings

NEW HERMES ENGRAVING MACHINE CORP..... 130
Engraving machines and accessories

NICE BALL BEARING CO..... 1060
Ball bearings, belt and chain idlers, cam followers, wire guides

C. A. NORGREN CO..... 910
Precision regulators, filters, regulators and lubricators

NUCLEAR PRODUCTS CO..... 209
Engineering machinery

THE NYLOK CORP..... 440
Self-locking bolts, nuts; threaded inserts

NYLON MOLDED PRODUCTS CORP 125
Cast nylon parts

OPW-JORDAN CORP..... 1202
Pressure regulators, temperature regulators, control valves, quick couplings, sight flow indicators, swivel joints, line strainers and controllers

THE OHIO GEAR CO..... 1136
Mechanical components

THE OHIO KNIFE CO..... 231
Die sections, machines ways, slides, & gibs, plastic granulating knives

OHIO RUBBER CO..... 610
Non-metallic materials

OHIO SEAMLESS TUBE DIV, COPPERWELD STEEL CO..... 811
Steel tubing, welded steel tubing

OLIN MATHIESON CHEMICAL CORP 601
Aluminum sheet, strip, extrusions, electrical wire and cable

ORANGE ROLLER BEARING CO, INC 1020
Bearings

O'SULLIVAN RUBBER CORP..... 359
Containers for consumer products, injection molded small parts

OWATONNA TOOL CO..... 1203
2-speed hydraulic power package, 2-speed hydraulic hand pump, double-acting hydraulic cylinders

OWENS-CORNING FIBERGLAS CORP 462
Reinforced plastic molded parts

OZALID DIV GENERAL ANILINE & FILM CORP. 200
Drafting equipment, supplies, duplicators, photo copy machines

P.I.C. DESIGN CORP..... 340
Gears and breadboard kits

PACK MANUFACTURING CO..... 1238
Interlock files & control accessories

PAKTRON DIV, ILLINOIS TOOL WORKS 844
Special purpose machines

PALL CORP 960
Hydraulic and pneumatic components

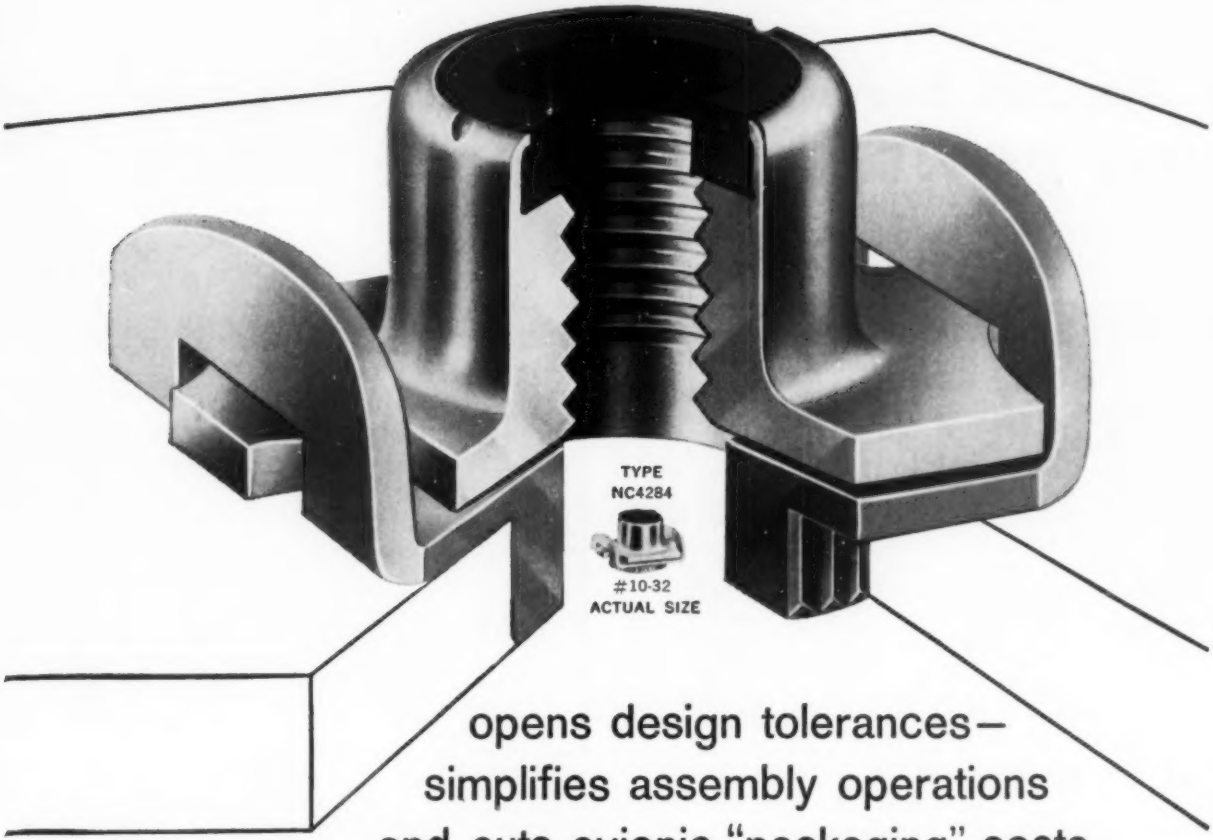
THE PALNUT CO..... 115
Lock nuts, lock washers, fasteners

PANDUIT CORP 1217
Plastic wiring, cable ties & clamps, spiral wrapping, and cable sheaths

PARAMOUNT TEXTILE MACHINERY CO 1254
Mechanical components

continued on page 134

NEW MINIATURIZED FLOATING CLINCH NUT



opens design tolerances– simplifies assembly operations and cuts avionic "packaging" costs.

Standard ESNA
Non-floating
Clinch Nut Types

REGULAR 250°F

NC

NKC

NKCFM

MINIATURE

NCFMA
350°F

LHCFM
550°F

Here at last is a reduced-dimension clinch nut and basket assembly that provides .020″ minimum radial float. Because the nut is able to compensate for minor bolt hole misalignment in the component to be attached, production line techniques can be simpler and faster.

This very lightweight type NC4284 nut offers the electromechanical engineer new design opportunities in the assembly of electronic chassis, panels, cover plates and many other "packaging" applications. Due to its very narrow basket this fastener requires less flange width for installation than any other similar-purpose press or stake-in type part.

The retaining basket has a precisely knurled shank which standard ESNA punch and dolly tools firmly embed into aluminum or mild steel sheets, for maximum security against twist-out or push-out forces. The new fastener is easily installed in a drilled or punched hole using a regular drill or arbor press.

ESNA's exclusive red nylon locking insert gives this nut a consistent locking torque through more than 50 on/off cycles. It guarantees reliable fastener performance for assemblies that demand frequent disassembly for maintenance or inspection needs. Yet the smooth grip of the nylon collar will not flake cadmium plating from the bolts. The special formula nylon accepts temperature environments from −65°F. to 350°F.

This new floating clinch nut is designed in both carbon steel and 303 FM stainless —in sizes No. 4, 6, 8, and 10. Each thread size is available in 2 shank lengths of .040″ and .060″ for flush installation in sheets of equivalent or greater thicknesses.

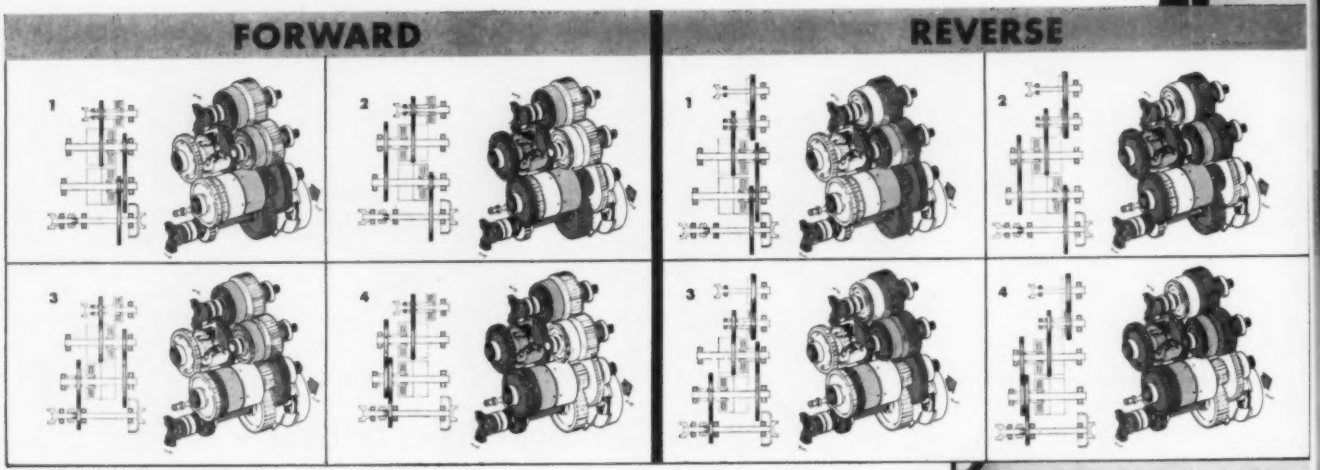
For complete specifications and installation instructions on new part NC4284 and many other lightweight avionic fasteners, write Dept. S58-545 for a copy of the new Aerospace Catalog No. 960.

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey

CIRCLE 131 ON READER SERVICE CARD 131

4 Speeds Forward...4 Speeds Reverse
FULL POWER SHIFT IN ALL RATIOS



New TWIN DISC TRANSMISSION

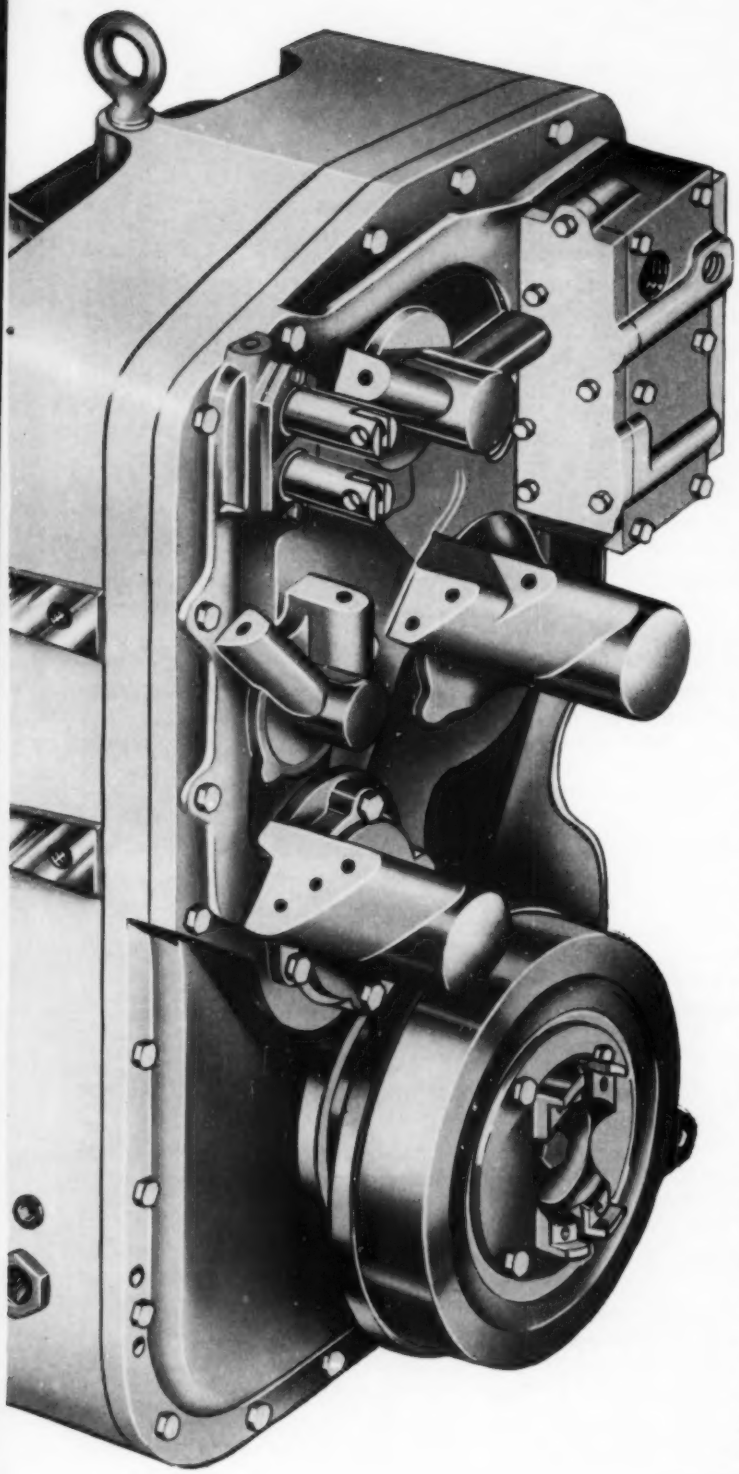
for engines in the 100 hp range

The Twin Disc "engine to axle" concept in OEM power transmission components takes another giant step forward with the introduction of the Series TD-44-400 Power-Sift Transmission. This new Twin Disc design is a four speed forward, four speed reverse box with full power-shifting in all speeds. Designed for engines developing from 75 net hp at 1800 rpm up to 108 net hp at 3000 rpm,* Series TD-44-400 includes two models with an over-all ratio coverage of 6.91:1. Model TD-44-403 has ratios of 4.89, 3.19, 1.08 and .705; Model TD-44-404 has ratios of 5.98, 3.92, 1.32 and .866.

*This is rated horsepower delivery after power is taken off for auxiliary drives.

Simple design, positive operation

The complexities of planetary designs are avoided in the transmission's simple countershaft arrangement. Multiple-disc oil-actuated clutches energize the constant-mesh spur gear trains, while speed changes are effected by two



duplex clutches that function as range clutches.

Two large single-plate clutches handle the direction-changing job. These clutches, oil-cooled for maximum heat dissipation, act as the energizing clutches for all engagements.

Shockless clutching

Clutches are engaged by means of a cascade system of oil pressure regulation. A controlled pressure rise valve increases the pressure steadily and rapidly. This patented feature makes for exceptionally smooth clutch engagement.

The brake-regulated clutch release valve is ported for direct connection to the vehicle's brake fluid system. Thus, by depressing the brake pedal, the operator releases all cutches in the transmission, instantly cutting off the power source for vehicle movement.

Both ends of the output shaft feature yoke-type U-joint connecting members as standard equipment. Also standard is a parking brake and a disconnect jaw clutch on the output shaft. This jaw clutch may be engaged for four wheel drive or disengaged for single axle drive.

Easy servicing

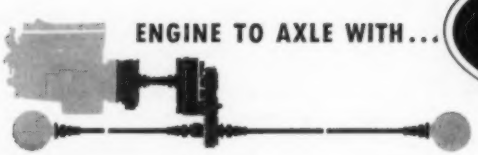
In designing the Series TD-44-400 Transmission, Twin Disc engineers have made easy servicing a prime requisite. Removal of the main housing cover gives complete access to all clutches and range gears. Anti-friction bearings are used throughout. The simple power train and relatively few parts can be readily appreciated when contrasted with the complex power flow and multiplicity of parts in a planetary gear transmission.

Torque converter-transmission package

The TD-44-400 Transmission is normally furnished with a Twin Disc Single-Stage Torque Converter as a package unit. The converter is a sumpless model featuring two power take-offs points. One is normally used for power steering. The other incorporates an SAE "C" pump mounting suitable for hydraulic power pumps.

Series TD-44-400 is one of a complete line of converter-transmission packages being developed at Twin Disc's Transmission Division. Twin Disc engineers will be pleased to make recommendations for these units in your vehicle drive. Contact the Transmission Application Engineering Department at our Racine office.

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin; *Hydraulic Division,* Rockford, Illinois.



ENGINE TO AXLE WITH...

TWIN DISC
POWER TRANSMISSION EQUIPMENT

CIRCLE 133 ON READER SERVICE CARD 133

WHO'S SHOWING WHAT . . . by exhibitor

PARK NAMEPLATE CO, INC..... 947
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PARKER-HANNIFIN CORP..... 544
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PENNSYLVANIA FLUOROCARBON CO, INC 357
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PERMACEL 212
Tapes, adhesives, silicone rubbers and epoxy resins

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POLORON PRODUCTS, INC..... 716
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POTTER & BRUMFIELD, DIV AMERICAN MACHINE & FOUNDRY CO 1162
Electromagnetic relays

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Magazine

PRECISION METAL MOLDING..... 1040
Magazine

PRESSWORK INC 1208
Metals

PRODUCT DESIGN & DEVELOPMENT 710
Magazine

PRODUCT ENGINEERING 263
Magazine

PRUDENTIAL INDUSTRIES, INC.... 505
Chains, sprockets, couplings, gears, electromechanical assemblies

RAMSEY CORP 1215
Retaining rings

RANDALL GRAPHITE BEARINGS, INC 1016
Retaining rings

RAYBESTOS-MANHATTAN, INC .. 918
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REED & PRINCE MANUFACTURING CO 1220
Standard and specialty fasteners

REVERE COPPER AND BRASS INC 521
Aluminum, brass and copper mill products, tube in-strip

REYNOLDS METALS CO..... 215
Aluminum mill products

M. H. RHODES 162
Time switches, time delay relays, mechanical timing devices

RIEHLE TESTING MACHINES DIV, AMERICAN MACHINE & METALS INC 857
Testing machines, engineering service

RIGIDIZED METALS CORP..... 1045
Stainless steel, aluminum, brass, copper, titanium forms

ROBBINS & MYERS, INC, ELECTRIC MOTOR DIV 356-360
Electric motors and motor parts

ROBERTSHAW-FULTON CONTROLS CO, ACRO DIV..... 223
Industrial controls

ROBERTSHAW-FULTON CONTROLS, BRIDGEPORT THERMOSTAT DIV. 223
Temperature controls

ROBERTSHAW-FULTON CONTROLS CO, FULTON SYLPHON DIV.... 223
Electrical and electronic components

ROBIN PRODUCTS CO..... 103
Fasteners

ROEHLEN ENGRAVING WORKS... 536
Plastic, paper, metal, wood, rubber embossing rolls and plates

ROHM & HESS CO..... 463
Plastics

ROLLER BEARING CO OF AMERICA 362
Bearings, followers, bushing assemblies

ROLLWAY BEARING CO, INC..... 117
Cylindrical roller bearings

ROPER HYDRAULICS, INC..... 119
Positive displacement pumps

ROSAN INC 337
Inserts, lock nuts and lock parts

ROTHERN ENGINEERING CO, INC 104
Joints, air nozzles and humidifiers

RUSSELL, BURDSALL & WARD BOLT AND NUT CO..... 937
Fasteners

SAGINAW STEERING GEAR DIV, GENERAL MOTORS CORP..... 845
Ball bearing screws and splines

SANDUSKY FOUNDRY AND MACHINE CO 405
Castings

A. SCHRADER'S SON, INC, DIV SCOVILL MANUFACTURING CO INC 642
Air cylinders, valves, controls

SCOTT PAPER CO, INDUSTRIAL MARKETING DIV 1112
Industrial foam

SCREEN PRODUCTS, INC..... 1117
Filter and screen assemblies

SCULLY-JONES AND CO..... 205
Recirculating roller way bearings, ball screws, spring pads for way bearings, recessing tools and chucks

SEALOL INC 1058
Mechanical seals, check valves

SELECTRONS, LTD 306
Engineering services

SHAKEPROOF DIV, ILLINOIS TOOL WORKS 844
Lock washers

SHWAYDER BROS, INC..... 1057
Finishes and coatings

SIGAMOTOR INC 1233
Tubing pumps, kinetic clamp units

SIGMA INSTRUMENTS INC..... 211
Electronic components

SIMMONS FASTENER CORP..... 957
Small, lightweight fasteners and components fastener

SIMPLATROL PRODUCTS CORP.... 1161
Electric clutches and brakes

SKINNER ELECTRIC VALVE DIV, THE SKINNER CHUCK CO..... 900
Solenoid valves

SNAP-TITE, INC..... 1029
Quick-disconnect couplings

THE SNOW NABSTEDT GEAR CO.. 1039
Transmissions and gears

SOUTHCO DIV, SOUTH CHESTER.. 1021
Fastening devices and latches

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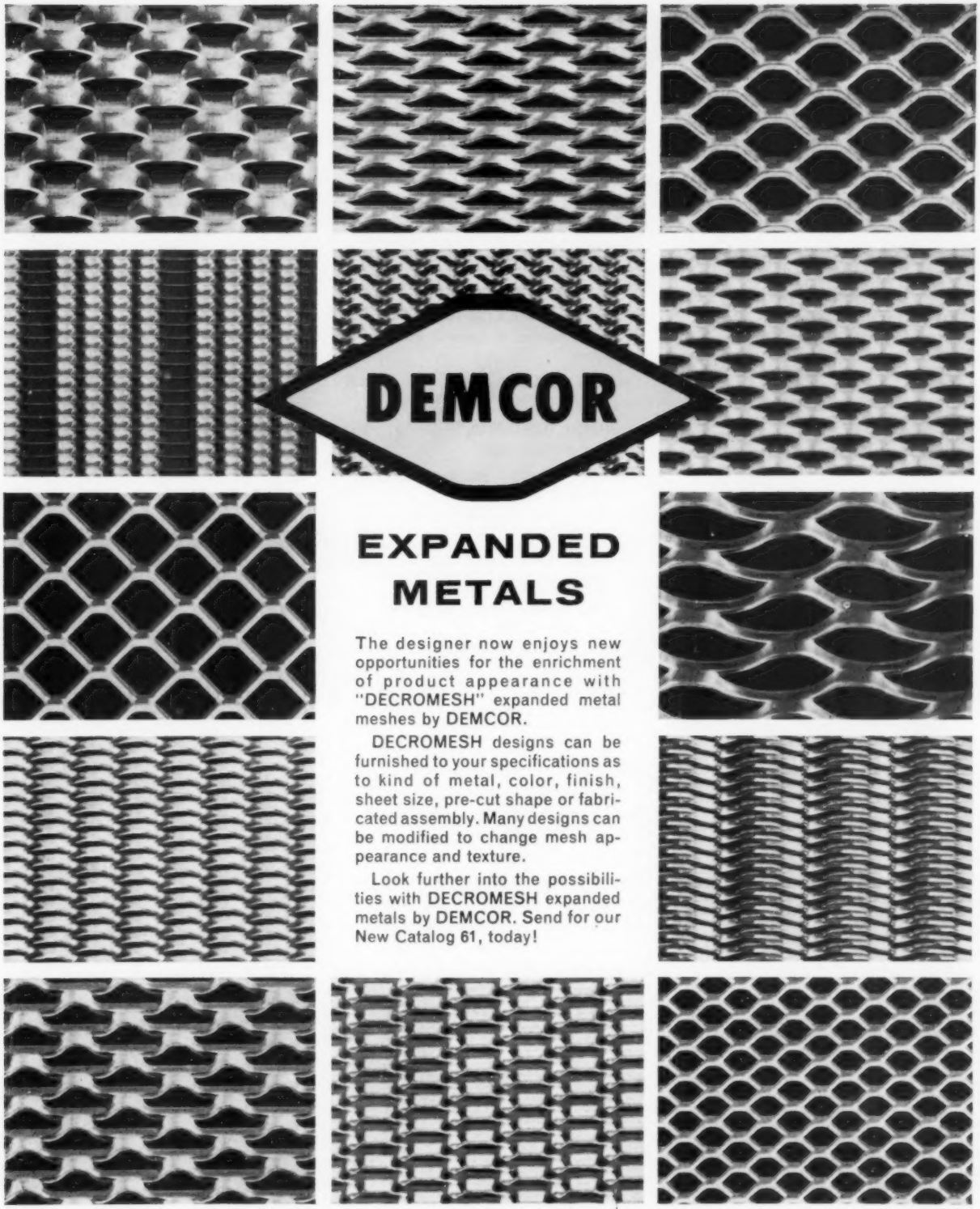

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CIRCLE 135 ON READER SERVICE CARD 135

WHO'S SHOWING WHAT . . . by exhibitor

SPACE/AERONAUTICS 320
Magazines

SPACE MISSILE MATERIALS CORP. 1256
Bars, metal and special shapes

SPAULDING FIBRE CO, INC..... 939
Phenolic and paper epoxy laminates, vulcanized fibers

SPIROID DIV, ILLINOIS TOOL WORKS 844
Specialty gears

STACOR EQUIPMENT CO..... 418
Drafting room furniture, filing cabinets for blueprints

STAHLIN BROS FIBRE WORKS, INC 1061
Raceways and connectors

STANDARD PRESSED STEEL CO... 815
Industrial and aircraft fasteners

STAR EXPANSION INDUSTRIES CORP 331
Fasteners for metal-to-wood, metal-to-metal, masonry

STER-BATH GEAR & PUMP CO, INC 958
Gear couplings and gears

STERLING PRECISION CORP..... 1001
Magnetic brakes, clutches, gears

STOKES MOLDED PRODUCTS DIV ELECTRIC STORAGE BATTERY CO 319
Molded containers, valves and pump components

STOW MANUFACTURING CO.... 150
Gear box, flexible shafts

STRATOFLEX INC 106
Hose fittings, assemblies, flexible hose

SUPERIOR TUBE CO..... 849
Exotic metals, alloys and tubing

SWEET'S CATALOG SERVICE, DIV F. W. DODGE CORP..... 663
Engineering services

SYLVANIA ELECTRIC PRODUCTS INC 542
Plated fine wire, welds, custom-molded plastics, custom-metal stampings

SYNTHANE CORP 143
Laminated plastics

SYNTRON CO 743
Conveying and feeding devices, dc conversion devices, motors

TANN CORP .....924 & 928
Bearings, proximity micro-gap switches, sealed circulating oil pillow blocks

TECHNICAL SERVICES DIV, ROGERS PUBLISHING CO 1009
Magazines

THE THOMAS & BETTS CO, INC... 228
Electrical connectors and fittings

THOMAS FLEXIBLE COUPLINGS CO 943
Flexible couplings for power transmission

THOMAS PUBLISHING CO..... 1239
Magazines

THOMSON INDUSTRIES, INC..... 962
Bushings and bearings

ARTHUR TICKLE ENGINEERING WORKS, INC 323
Metal spraying, coatings, precision work

TIMMERMAN PRODUCTS, INC..... 345
Specialty fasteners

TORMAG PRODUCTS DIV OF GLEASON REEL CORP..... 1015
Power transmission equipment

TOYAD CORP 344
Sponges and forms

TRADE NAME PRODUCTS..... 919
Silicone rubber

TUBULAR RIVET AND STUD CO... 350
Fastening machines

THE UCINITE CO, DIV UNITED-CARR FASTENER CORP..... 1240
Engineered components

UNION CARBIDE CORP..... 621
See division listings

UNION CARBIDE CHEMICALS CO, TEXTILE FIBERS DIV OF UNION CARBIDE CORP 621
Chemical products

UNION CARBIDE METALS CO, DIV UNION CARBIDE CORP..... 621
Metals and alloys

UNION CARBIDE PLASTICS CO, DIV UNION CARBIDE CORP.... 621
Plastic resins and materials, coatings, films

UNITECH CORP 1127
Drawing machines

UNITED SHOE MACHINERY CORP 400 404 & 408
Transmissions and fasteners

U. S. ELECTRICAL MOTORS INC.. 508
Controlled speed systems and electric motors

U. S. GAUGE DIV, AMERICAN MACHINE & METALS INC..... 857
Engineering instruments

UNITED STATES PLYWOOD CORP 126
Structural panels

UNITED STATES RUBBER CO, MECHANICAL GOODS DIV..... 762
Timing belt drives, flexible couplings, V-belts, molded parts

UNITED STATES STEEL..... 626
Solenoid valves

U. S. STONEWARE CO..... 919
Coatings, plastic tubings, gasketing

UNIVERSAL CASTINGS CORP.... 325
Plaster mold castings

UNIVERSAL DRAFTING MACHINE CORP 432
Drafting room equipment

VALCOR ENGINEERING CORP... 1243
Teflon solenoid valve, 2- 3- and 4-way pneumatic and hydraulic valves

VANTON PUMP & EQUIPMENT CORP 127
Plastic valves, pumps, fittings

VEEDER-ROOT INC 243
Mechanical, electromechanical and electronic counting instruments

VICKERS INC 549
Speed drives, pumps, valves and hydraulic power units

VIKING PUMP CO..... 1231
Pumps and drives

WALDES KOHINOOR, INC, TRUARC RETAINING RINGS DIV..... 1018
Retaining rings, ring pliers, grooving tools, groove location gage

WALDRON-HARTIG DIV, MIDLAND-ROSS CORP 327
Pressed steel parts

O. S. WALKER CO, INC..... 2418
Low frequency demagnetizer

WALL COLMONOY CORP, STAINLESS PROCESSING DIV..... 1234
Special alloys

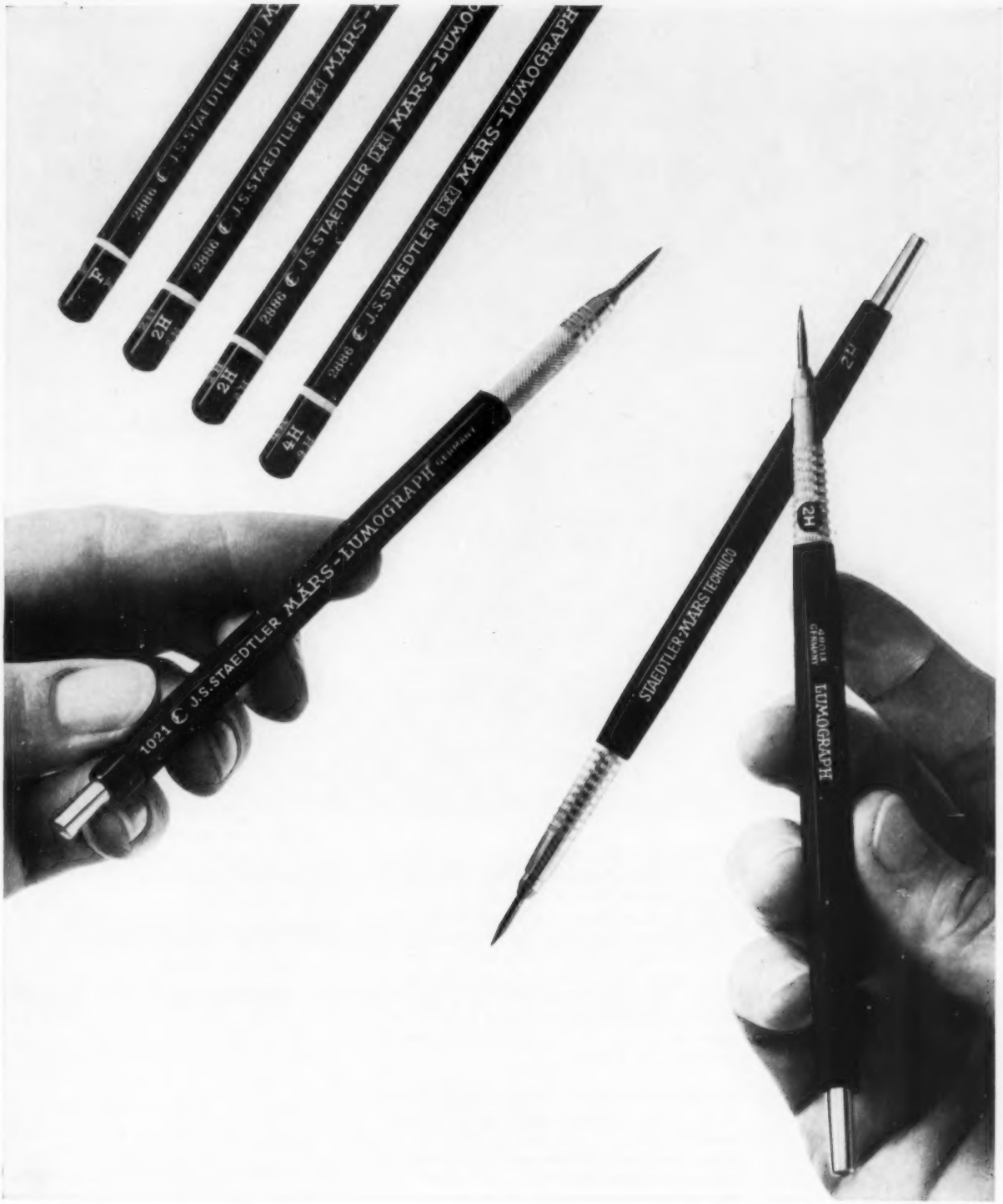
WARNER AUTOMOTIVE DIV, BORG-WARNER CORP 501
Right angle drive gear boxes

WARNER ELECTRIC BRAKE & CLUTCH CO 700
Clutches and brakes

WASHINGTON STEEL CORP..... 856
Stainless steel sheet and strip

WAUKESHA FOUNDRY CO..... 616
High-temperature, corrosion-resistant castings

continued on page 138



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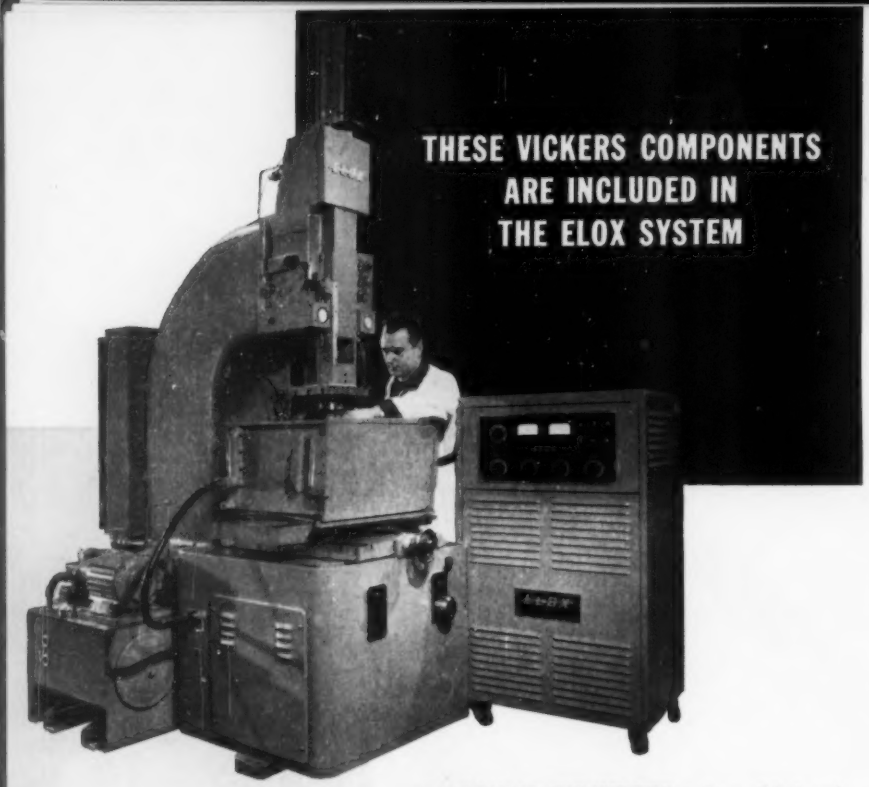
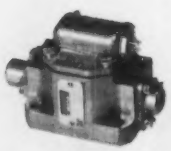
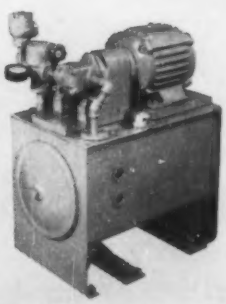


THESE VICKERS COMPONENTS ARE INCLUDED IN THE ELOX SYSTEM

HYDRAULIC CYLINDERS—Low frictional drag and dependable operation of the 3-inch bore, 12-inch stroke cylinders makes them ideal for the Elox machine shown. Vickers builds a complete line of cylinders and offers a wide choice of mounting options, rod end threads, wrench flats, port positions and connections. Standard bore sizes range from 1½" to 8" with either standard or heavy duty rods; special designs can be provided to suit every application. For more details ask for Bulletin 60-68.



SERVO VALVES—Extremely critical requirements for low deadband and high response for instantaneous reversals to clear the electrode dictated the selection of a Vickers servo valve for the Elox spark discharge machine. Three series of Vickers servo valves are available to meet every type of industrial application: a single stage valve rated at 0-3 gpm and two series of 2-stage servo valves for flows of 0-17 gpm and 0-37 gpm. For more details ask for Bulletins 59-74, 61-79.



POWER PACKAGE—The standard Vickers T-10 power package supplies the steady pressure required for optimum operation of the Elox electrical discharge machine. A vane pump and relief valve matched to the system plus the basic tank unit constitute the power package. Vickers builds the most complete range of power packages available anywhere—all components "matched" in output to insure optimum performance and reliability. For more data on how these power packages can simplify your design and procurement problems, contact your Vickers Application Engineer.

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1961 DESIGN SHOW

WHO'S SHOWING WHAT... by exhibitors

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Metal tube fittings, hoses and hose ends, screw machine products, swaging machines

WEB CONTROLS CORP..... 247
Automatic torque, tension and speed controls

WECKESSER CO 100
Clamps, straps, plastic molder parts, threaded rods

WELDING DESIGN & FABRICATION 1040
Engineering equipment and services

WESTCHESTER PLASTICS, INC.... 1028
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WESTPLEX CORP 1156
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THE S. S. WHITE DENTAL MFG. CO, INDUSTRIAL DIV..... 916
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Electric heaters and elements for industrial processing

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WILKERSON CORP 107
Filters and lubricators

WITTEK MANUFACTURING CO.... 526
Hose clamps, auto clamps and band clamps

WOLVERINE TUBE, DIV CALUMET & HECLA, INC..... 1111
Titanium

T. B. WOOD'S SONS CO..... 901
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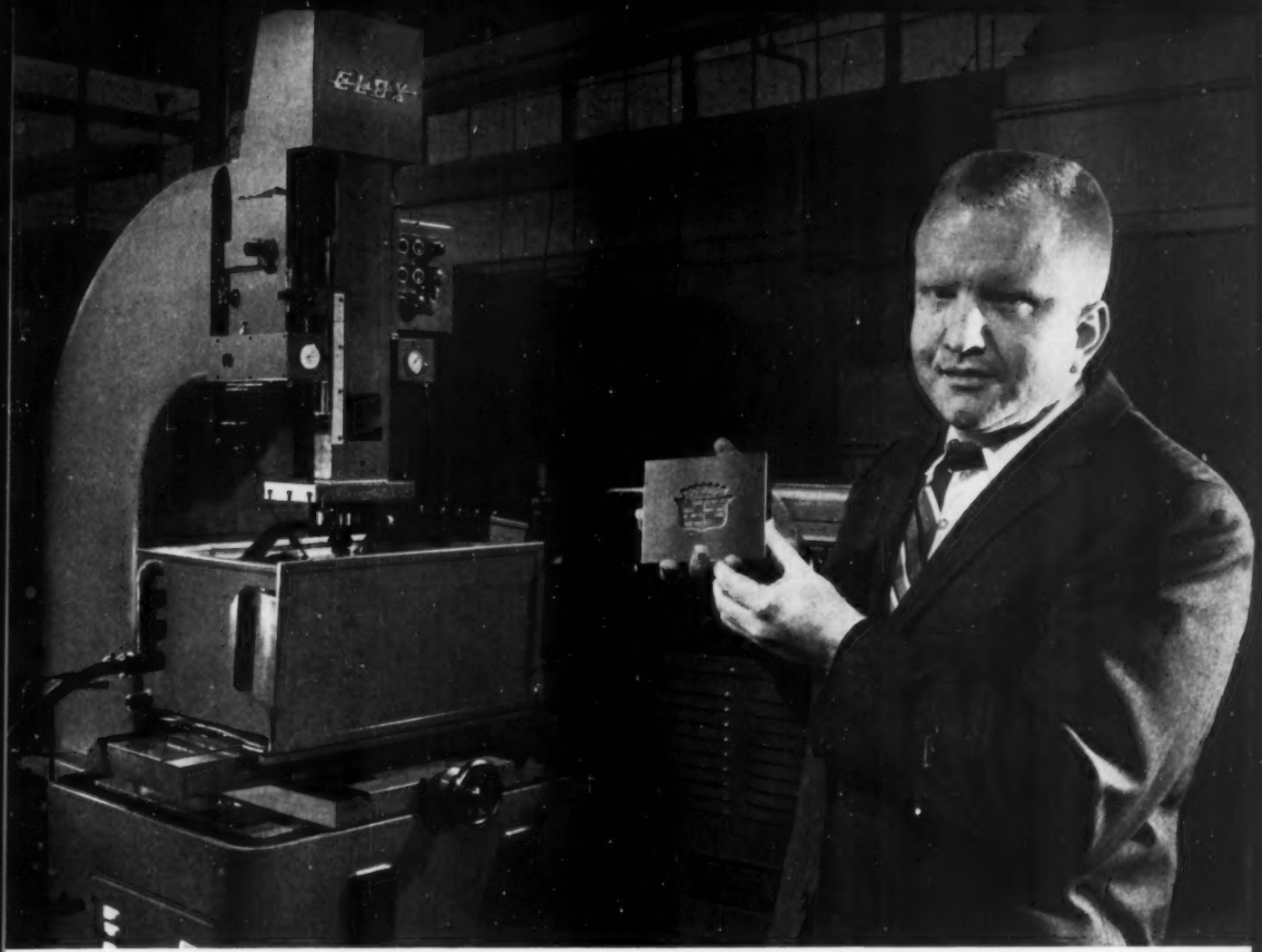
WOOSTER DIV, BORG-WARNER CORP 501
Hydraulic pumps and electric driven accessories

WORTHINGTON CORP 308
Pumps, all-speed drives, motor drives, motor pulleys

ZENITH ELECTRIC CO..... 1237
Switches, contractors and detectors



ROBERT WEBB, RESEARCH DIRECTOR, ELOX CORPORATION SAYS:

"Jointly developed hydraulic system provides fast response needed for spark machining..."

"When people have a problem that can be solved with three-dimensional electric discharge machining, they come to Elox for our special skills and knowledge. Similarly, we insure that our machines offer the last word in performance by working as a team with components and systems manufacturers.

"To produce cavity dies like the one shown above, we designed and built a machine with a precision table and a vertical slide accuracy that we can guarantee within .0005" to 12 inches. We were able to develop a hydraulic circuit for the vertical slide and get a faster response than with any other method because Vickers engineers understood our problems thoroughly and cooperated fully in effecting their solution.

"Speed of response is half the story; the other is precise maintenance of the spark gap without 'hunting'—enabling the spark machining operation to be completed in the shortest possible cycle. Our hydraulic package meets all the foregoing requirements because the individual units are matched to each other and to the machine itself."

The Elox experience is typical of Vickers assistance to machinery builders and/or users in providing outstanding hydraulic equipment or systems to insure peak performance. Specialists working with the broadest line of top quality hydraulic components available anywhere give you a system ideally suited to your specific needs. See facing page for more details about the hydraulic components used by Elox and the entire Vickers line.

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CIRCLE 139 ON READER SERVICE CARD

9640

1961 DESIGN SHOW

WHO'S SHOWING WHAT . . . by product

MECHANICAL COMPONENTS

Aetna Ball and Roller Bearing Co.—213
Air-Maze Corp.—160
Aluminum Co. of America—721
Amco Engineering Co.—449
American Koyo Corp.—1109
American Machine & Metals, Inc.—857
American Stock Gear Div., Perfection Gear Co.—1212
Amplex Div., Chrysler Corp.—1142
The Anderson Co.—800
Arch Instrument Co., Inc.—1011
Arguto Oilless Bearings Co.—210
The Artus Corp.—1049
Associated Spring Corp.—445
Atlas Chain & Manufacturing Co.—505
The Auburn Manufacturing Co.—540
B-Mold Div., Buckeye Brass & Mfg. Co.—1032
Barry Controls, Incorporated—904
Beaver Precision Products, Inc.—410
Binks Manufacturing Co.—519
Boston Gear Works—342
Carr Fastener Co., Div. United-Carr Fastener Corp.—1242
Chain Belt Co.—929
Chicago Allis Manufacturing Corp.—154
Cleveland Graphite Bronze Div. of Clevite Corp.—121
Commercial Filters Corp.—214
Controlex Corp. of America—122
Corbin Cabinet Lock Div., The American Hardware Corp.—1223
Cramer Controls Corp.—1124
Crane Packing Co.—237
Dayton Industrial Products Co., Div. of Dayco Corp.—1017
Disogrin Industries—1235
Dixon Sintaloy Inc.—1059
Duff-Norton Co.—401
Dynamic Gear Co., Incorporated—134
Dzus Fastener Co., Inc.—428
Eaton Manufacturing Co.—656
Eriez Manufacturing Co.—245
Falstrom Co.—821
Faultless Caster Corp.—1038
Fawick Airflex Div., Fawick Corp.—224
Flexible Controls Corp.—1140
Garlock Inc.—618
General Bearing Co.—1132
General Electric Co.—423
Gleason Reel Corp.—1015 Gleason Works—500
Gries Reproducer Corp.—1143
Hart Reduction Pulley Co.—109
Hartford Steel Ball Co.—1205
The Hartwell Corp.—915
The Heim Co.—843
Heyman Manufacturing Co.—218
Hoover Ball and Bearing Co.—1062
Hunter Spring Co., A Div. of American Machine & Metals, Inc.—857
Illinois Tool Works—844
Industrial Tectronics, Inc.—1000
Instrument Specialties Co., Inc.—343
International Packings Corp.—742
The Kaydon Engineering Corp.—137
Kennametal Inc.—562
Landis & Gyr, Inc.—1160
Lignum-Vitae Products Corp.—144
Link Belt Co.—743
Lord Manufacturing Co.—912
MM Enclosures, Inc., Affiliated with A & P Metal Products Mfg. Corp.—123
Manheim Mfg. & Belting Co.—1241
Marlin-Rockwell Corp.—. . . .
Maysteel Products, Inc.—1015
McGill Manufacturing Co., Inc.—1031
Metal Powder Industries Federation—826
Minnesota Mining & Manufacturing Co., Chemical Div.—550
Mono-Race Div., The Thew Shovel Co.—412
Mueller Brass Co.—701
National Tube Div., United States Steel—626
New Departure Div., General Motors Corp.—118
Nice Ball Bearing Co.—1060
The Ohio Gear Co.—. . . .
Ohio Seamless Tube Div. of Copperweld Steel Co.—811
Orange Roller Bearing Co., Inc.—1020
Owatonna Tool Co.—1203
Paktron Div., Illinois Tool Works—844
Paramount Textile Machinery Co.—1254
Park Nameplate Co., Inc.—947
P. I. C. Design Corp., Subsidiary of Benrus Watch Co.—340
The Polymer Corp.—1105
Ramsey Corp.—1215
Randall Graphite Bearings, Inc.—1016
Raybestos-Manhattan, Inc.—918
Robbins & Myers, Inc.—356
Roller Bearing Co. of America—362
Rollway Bearing Co., Inc.—117
Sandusky Foundry & Machine Co.—405
Screen Products, Inc.—1117
Scully-Jones and Co.—205
Sealol Inc.—1058
Sier-Bath Gear & Pump Co.—958
Sigmamotor Inc.—1233
Simmons Fastener Corp.—957
Spiroid Div., Illinois Tool Works—844
Sterling Precision Corp.—1001
Edwin B. Stimpson Co., Inc.—1100
Stokes Molded Products Div. of The Electric Storage Battery Co.—319
Stow Manufacturing Co.—150
Syntron Co.—743
Tann Corp., Congress Drives Div.—924
Thomson Industries, Inc.—962
Tormag Products Div. of Gleason Reel Corp.—1015
United Shoe Machinery Corp.—400
U. S. Electrical Motors Inc.—508
U. S. Gauge Division, American Machine & Metals, Inc.—857
Vanton Pump & Equipment Corp., Div. of Cooper Alloy Corp.—127
Veeder Root Incorporated—243
Warner Automotive Div., Borg Warner Corp.—501
Web Controls Corp.—247
Westplex Corp.—1156
The S. S. White Dental Mfg. Co.—916
Wilkerson Corp.—107

POWER TRANSMISSION EQUIPMENT

Acme Chain Corp.—1004
Aluminum Co. of America—721
AMP Incorporated—932
Anaconda Metal Hose Div., The American Brass Co.—312
The Anderson Co., Roton Products Div.—800
Arguto Oilless Bearing Co.—210
The Artus Corp.—1049
Beaver Precision Products, Inc.—410
Bendix Corp., Eclipse Machine Div.—1147
Boston Gear Works—342
Browning Manufacturing Co.—251
Chain Belt Co.—929
Chicago-Allis Manufacturing Corp.—154
Cleveland Graphite Bronze Div. of Clevite Corp.—121
Congress Drives Div., Tann Corp.—924
Controlex Corp. of America—122
Cullman Wheel Co.—1144
Cycledynamics, Inc.—1206
Dayton Industrial Products Co., Div. of Dayco Corp.—1017
De Laval Steam Turbine Co.—836
Diamond Chain Co., Inc.—1228
Dodge Manufacturing Corp.—322
Duff-Norton Co.—401
Eaton Manufacturing Co.—656
Eclipse Machine Div., The Bendix Corp.—1147
Fawick Airflex Div., Fawick Corp.—224
Foote Bros. Gear and Machine Corp.—444
Formsprag Co.—736
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Graham Transmissions Inc.—960
The Heim Co.—843
The Hilliard Corp.—1120
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Link-Belt Co.—743
Lovejoy Flexible Coupling Co.—1044
Maurey Manufacturing Corp.—346
McGill Manufacturing Co., Inc.—1031

continued on page 142

Giant Radar Guards Our Shores...

ALEMITE OIL MIST WITH THERMO-AIRE® GUARDS ITS GIANT BEARING!

The FPS-35 radar at Montauk Air Force Station, designed and developed by Sperry Gyroscope Company, is one of the largest in the world. The huge 140,000-pound antenna assembly rides on a precision-built azimuth bearing with an outside diameter of 160.500-inches. This bearing is machined to fit its retainer with a total looseness of no more than 0.006 of an inch.

10-years of continuous operation, with only four 24-hour shutdowns a year for servicing maintenance, is the life design-requirement for this antenna. For the all-important job of lubricating this azimuth bearing, Sperry Engineers selected Alemite Oil-Mist with Thermo-Aire. Oil-Mist provides the *fully-automatic, continuous, all-over* lubrication protection this bearing positively requires for trouble-free operation.

Oil-Mist with the new, exclusive Thermo-Aire enables Sperry's Engineers to eliminate guesswork lubrication assuring greater efficiency . . . longer bearing life. Oil-Mist is extra-clean; does away with drippings. Thermo-Aire permits atomization of the heaviest mineral oils and applies them automatically and continuously.

Find out how Alemite Oil-Mist can protect many of your designs against wear and breakdown. Write for free Oil-Mist catalog, or see your Alemite representative.

Symbol of SW Excellence

ALEMITE DIVISION
STEWART-WARNER CORPORATION

In Canada: Stewart-Warner Corporation of Canada Ltd., Belleville, Ontario

Dept. CC-51, 1850 Diversey Parkway, Chicago 14, Illinois

CIRCLE 141 ON READER SERVICE CARD 141

Morse Chain Co., A Borg-Warner Industry—842
National Tube Div., United States Steel—626
New Departure Div., General Motors Corp.—118
Randall Graphite Bearings, Inc.—1016
Raybestos-Manhattan, Inc.—918
Rollway Bearing Co., Inc.—117
Saginaw-Steering Gear Div., General Motors Corp.—845
A. Schrader's Sons, Inc., Div. of Scovill Manufacturing Co., Inc.—642
Scully-Jones and Co.—205
Sealol Inc.—1058
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Sigmamotor Inc.—1233
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Sterling Precision Corp.—1001
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Tann Corp., Congress Drives Div.—924
Thomas Flexible Coupling Co.—943
Tormag Products Div. of Gleason Reel Corp.—1015
United Shoe Machinery Corp.—400
U. S. Electrical Motors Inc.—508
United States Rubber Co., Mechanical Goods Div.—762
Waldron-Hartig Div., Midland-Ross Corp.—327
Warner Electric Brake & Clutch Co.—700
Web Controls Corp.—247
Winsmith Inc.—1244
T. B. Wood's Sons Co.—901
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ACF Electronics Div., ACF Industries, Inc.—1023
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The Louis Allis Co.—945
Aluminum Co. of America—721
AMP Incorporated—932
Anaconda Metal Hose Div., The American Brass Co.—312
The Anderson Co., Roton Products Div.—800
The Artus Corp.—1049
The Auburn Manufacturing Co.—540
Automatic Switch Co.—825
Bendix Corp., Eclipse Machine Div.—1147
Bendix Computer Div., The Bendix Corp.—1147
W. H. Brady Co.—321
The Bristol Co.—1036
Brook Motor Corp.—1121
The Brush Beryllium Co.—657
Buchanan Electrical Products Corp.—720
Burling Instrument Co., Inc.—124
Carr Fastener Co., Div., United-Carr Fastener Corp.—1242
Carter Controls, Inc.—1005
Century Electric Co.—921
Cherry Electrical Products Corp.—1118
Circle F Mfg. Co.—422
Cleveland Graphite Bronze Div. of Clevite Corp.—121
Cleveland Machine Controls Corp.—336
Columbus Electric Manufacturing Co.—1055
Coors Porcelain Co.—1262
Corbin Cabinet Lock Div., The American Hardward Corp.—1223
Crane Packing Co.—237
Deluxe Coils, Incorporated—1116
Detroit Controls Div. of American Radiator & Standard Sanitary Corp.—257
Dixon Sintaloy Inc.—1059
The Dobeckmun Co., A Div. of the Dow Chemical Co.—745
E. I. du Pont de Nemours & Co., (Inc.), Film Department—860
Durakool, Inc.—442
Eagle Signal Corp.—1014
Eaton Manufacturing Co.—656
Ebert Electronics Corp.—1119
Eclipse Machine Div., The Bendix Corp.—1147
Electric Boat Div. of General Dynamics Corp.—709
Electric Dynamic Div. of General Dynamics Corp.—1112
Electro-Flux Heat, Inc.—112
Electro-Mechanical Instrument Co.—1148
ETC Incorporated—1157
Fawick Airflex Div., Fawick Corp.—224
Fenwal Incorporated—460
Flexible Controls Corp.—1140
Franklin Electric Co., Inc.—1052
Garlock Inc.—618
General Controls Co.—1024
General Electric Co.—423
Gleason Reel Corp.—1015
Gries Reproducer Corp.—1143
Haydon Div. of General Time Corp.—853
Heinemann Electric Co.—1247
Heyman Manufacturing Co.—218
Illinois Tool Works—844
Instrument Specialties Co., Inc.—343
Janette Mfg. Co., Subs. of National Pneumatic Co., Inc.—101
Landis & Gyr, Inc.—1160
Lead Industries Association—111
Licon Div., Illinois Tool Works—844
Linemaster Switch Corp.—1145
Martin Engineering Co.—138
Metals & Controls, Inc., Div. Texas Instruments Inc.—1201
Miller Electric Co.—300
Minneapolis-Honeywell Regulator Co.—1246
Mueller Brass Co.—701
Mycalex Corp. of America—1063
National Beryllia Corp.—1134
National Tube Div., United States Steel—626
New Departure Div., General Motors Corp.—118
Panduit Corp.—1217
Permacel—212
P.I.C. Design Corp., Subsidiary of Benrus Watch Co.—340
The Polymer Corp.—1105
Potter & Brumfield, Div. of American Machine & Foundry Co.—1162
Ramsey Corp.—1215
Randall Graphite Bearings, Inc.—1016
Reynolds Metals Co.—215
M. H. Rhodes, Incorporated—162
Riehle Testing Machines Div., American Machine & Metals, Inc.—857
Robbins & Myers, Inc.—356
Robertshaw-Fulton Controls Co., Acro Div.—223, Bridgeport Thermostat Div.—223
Scully-Jones & Co.—205
Sigma Instruments, Inc.—211
Simplatrol Products Corp.—1161
Space Components Inc.—211
Stahlin Bros. Fibre Works, Inc.—1061
Sterling Precision Corp.—1001
Edwin B. Stimpson Co., Inc.—1100
Stokes Molded Products Div., of The Electric Storage Battery Co.—319
Sylvania Electric Products Inc.—542
Syntron Co.—743
Texas Instruments, Inc., Metals and Controls Div.—1201
The Thomas & Betts Co., Inc.—228
United Shoe Machinery Corp.—400
U. S. Electrical Motors Inc.—508
Veeder-Root Incorporated—243
Warner Electric Brake & Clutch Co.—501
Web Controls Corp.—247
Westinghouse Electric Corp.—356
Westline Products Div. of Western Lithograph Co.—142
Edwin L. Wiegand Co.—220
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Acme Steel Co.—301
Alloy Casting Institute—329
Aluminum Co. of America—721
American Nickeloid Co.—1042
American Smelting & Refining Co.—711
American Zinc Institute—712
Armco Steel Corp.—409
Bendix Foundries, The Bendix Corp.—1146
The Beryllium Corp.—520
The Brush Beryllium Co.—657
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CIRCLE 143 ON READER SERVICE CARD→

For Your Power Drive • Design • Application or Replacement Maintenance

There's a T-J CYLINDER

That Can Assure *Accurate Efficient Operation*

Only T-J's complete line can assure you a cylinder of either air or hydraulic application—with practically limitless design specifications for bore, stroke, pressure range and even delivery requirement. From the time-tested, standard tie-rod air and hydraulic, to the exclusive T-J Spacemaker, and including the recently introduced Squair Head, T-J cylinders give you more features for efficient, long-lasting operation. Write today!

Plus

THE ONLY COMPLETE ENGINEERING CATALOG LINE, TOO!

H-47 for standard tie-rod hydraulic cylinders.

SQ-1058-4 for the T-J Squair Head cylinder.

No. 54 for standard tie-rod air cylinders.

SM-56-3 for the incomparable Spacemaker cylinder.

HSM5-56-4 for the High-Pressure Hydraulic Spacemaker cylinder.

THE TOMKINS • JOHNSON CO. JACKSON, MICH.

CYLINDERS • MILLING CUTTERS • RIVETERS and CLINCHERS

Cleveland Graphite Bronze Div. of Clevite Corp.—121
Climax Molybdenum Co., A Div. of American Metal Climax Co.—511
Copper & Brass Research Association—528
Curtiss-Wright Corp., Marquette Div.—1219
The Decatur Casting Co.—955
Drop Forging Association—204
Eaton Manufacturing Co.—656
Gleason Reel Corp.—1015
Gray Iron Founders' Society, Inc.—305
Hamilton Foundry Inc.—744
Handy & Harman—516
Haynes Stellite Co., Div. of Union Carbide Corp.—621
The International Nickel Co., Inc.—529
Janney Cylinder Co.—1163
Johnson Bronze Co.—1012
Jones & Laughlin Steel Corp., Stainless and Strip Div.—737
Kaiser Aluminum & Chemical Sales, Inc.—611
Kennametal Inc.—562
Laminated Shim Co., Inc.—116
LaSalle Steel Co.—563
Lead Industries Association—111
Magnesium Products of Milwaukee, Inc.—1015
The Malayan Tin Bureau—1047; Malleable Castings Council—700
Maysteel Products, Inc.—1015
McLouth Steel Corp.—810
Metal Powder Industries Federation—826
Mott Metallurgical Corp.—1115
Mueller Brass Co.—701
National-Standard Co.—801
New Departure Div., General Motors Corp.—118
The Ohio Knife Co.—231
Ohio Seamless Tube Div. of Copperweld Steel Co.—811
Olin Mathieson Chemical Corp., Metals Div.—601
Poloron Products, Inc.—716
H. K. Porter Co., Inc. Riverside—Alloy Metal Div.—609
Presswork Inc.—1208
Randall Graphite Bearings, Inc.—1016
Republic Steel Corp.—543
Revere Copper and Brass Incorporated—521
Reynolds Metals Co.—215
Rigidized Metals Corp.—1045
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Union Carbide Corp.—621
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United States Steel—626
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American Smelting & Refining Co.—711
The Auburn Manufacturing Co.—540
Automotive Rubber Co.—932
Avery Lavel Co., A Div. of Avery Adhesive Products, Inc.—905; AviSun Corp.—419
W. H. Brady Co.—321
Celanese Plastics Co., a Div. of Celanese Corp. of America—645
Chicago-Allis Manufacturing Corp.—154
Colonial Rubber Co.—919
Columbus Coated Fabrics Corp.—525
Conneaut Rubber & Plastics Co.—919
Continental-Diamond Fibre Corp.—156
Coors Porcelain Co.—1262
Crane Packing Co.—237
Disogran Industries—1235
Dixon Corp.—146
The Dobeckmun Co., A Div. of the Dow Chemical Co.—745
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E. I. du Pont de Nemours Co., (Inc.), Elastomers Department—761; Film Dept.—860
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Eastman Chemical Products, Inc., Plastics Div.—812
Enfab, Inc.—232
Enjay Chemical Co., A Div. of Humble Oil & Refining Co.—600
Fiberfil Inc.—1101
Garlock Inc.—618
Glass Laboratories, Inc.—148
Hexcel Products Inc.—1053
Hungerford Plastics Corp.—610
Lancaster Glass Corp.—304
Lead Industries Association—111
Lehigh Chemical Co.—1253
Lignum-Vitae Products Corp.—144
Marbon Chemical Div., Borg-Warner Corp.—725
The Masland Duraleather Co.—949
Minnesota Mining and Manufacturing Co.—550
Mycalex Corp. of America—1063
National Beryllia Corp.—1134
National Carbon Co., Div. of Union Carbide Corp.—621
National Lead Co.—345
National Vulcanized Fibre Co.—421
New England Laminates Co., Inc.—1147
Nylon Molded Products Corp.—125
Ohio Rubber Co.—610
O'Sullivan Rubber Corp.—359
Pennsylvania Fluorocarbon Co., Inc.—357
Permacel—212
Polygon Plastic Co.—1251
The Polymer Corp.—1105
Raybestos-Manhattan, Inc.—918
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Scott Paper Co.—1112
Scott Paper Co., Industrial Marketing Div.—1112
Spaulding Fibre Co., Inc.—939
Stokes Molded Products Div. of The Electric Storage Battery Co.—319
Synthane Corp.—143
Toyad Corp.—344
Union Carbide Chemicals Co., Textile Fibers Div. of Union Carbide Corp.—621
Union Carbide Corp.—621
Union Carbide Plastics Co., Div. of Union Carbide Corp.—621
United States Plywood Corp.—126
United States Rubber Co., Mechanical Goods Div.—762
United States Steel—626
U. S. Stoneware Co.—919
Westchester Plastics, Inc.—1028
Westline Products Div. of Western Lithograph Co.—142

FASTENERS AND ADHESIVES

Acme Steel Co.—301
Aluminum Co. of America—721
American Screw Co.—835
American Sealants Co.—131
AMP Incorporated—932
The Auburn Manufacturing Co.—540
Avery Label Co., Div. of Avery Adhesive Products, Inc.—905
W. H. Brady Co.—321
The Bristol Co.—1036
Carr Fastener Co., Div., United-Carr Fastener Corp.—1242
Chicago Rivet and Machine Co.—1218
Corbin Cabinet Lock Div., The American Hardware Corp.—1223
Dzus Fastener Co., Inc.—428
Eastman Chemical Products, Inc., Chemicals Div.—719
Eaton Manufacturing Co.—656
Elastic Stop Nut Corp. of America—720
Elizabeth Div., Elastic Stop Nut Corp. of America—720
Fasson Products, A Div. of Avery Adhesive Products, Inc.—416
Ferry Cap & Set Screw Co.—809
H. B. Fuller Co.—1129
B. F. Goodrich Aviation Products, A Div. of B. F. Goodrich Co.—420
Gries Reproducer Corp.—1143
Groov-Pin Corp.—1221
John Hassall, Inc.—927
Kaynar Manufacturing Co.—1010

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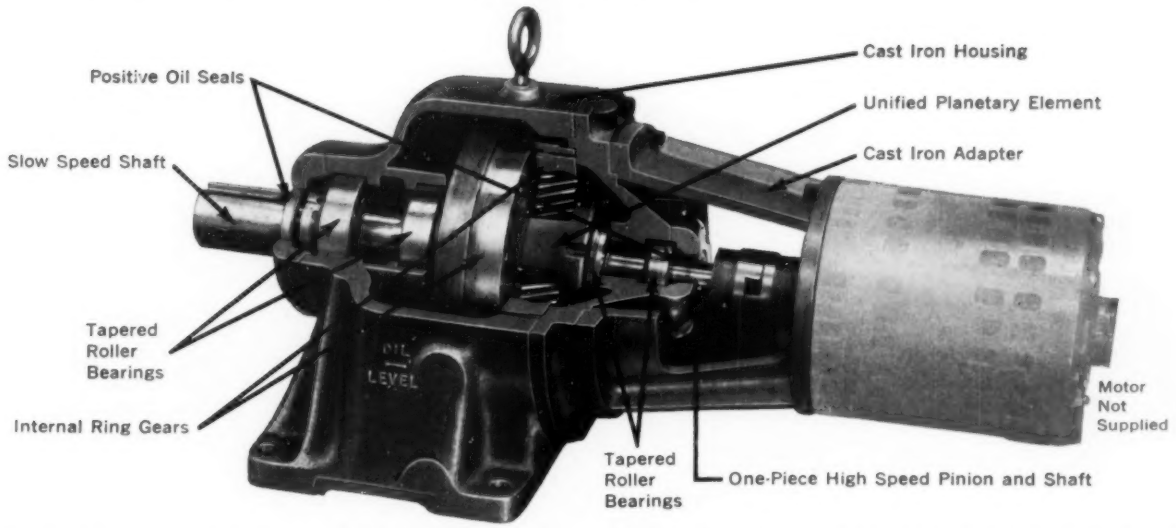
Engineering Data

WINSMITH SPEED REDUCERS

HORIZONTAL MOTORIZED DIFFERENTIAL SPEED REDUCERS



CAST IRON HOUSING—designed for high heat radiation. One-piece construction, close-grained gray iron for maximum strength and rigidity.

UNIFIED PLANETARY ELEMENT—integral primary and secondary planetary gears, mounted in a ductile iron cage—for even wear, equalized load, smooth operation. Hardened and ground, alloy steel gears carry entire power transmission load.

CAST IRON ADAPTER—permits use of any standard "C" flange motor. Flexible coupling (optional) connects motor to input shaft which can be driven in either direction.

INTERNAL RING GEARS—primary and secondary. Cut from alloy steel, heat treated for wear resistance.

ONE-PIECE HIGH SPEED PINION AND SHAFT—machined from alloy steel with teeth cut integral with the shaft. Hardened and accurately ground to close limits.

SLOW SPEED SHAFT—heat treated, precisely ground alloy steel. Low speed gear web of ductile iron.

TAPERED ROLLER BEARINGS—opposed pairs support the radial load, take thrust, ensure permanent alignment of both input and output shafts.

POSITIVE OIL SEALS—chevron type, keep oil in, dirt out. Oil and heat resistant, non-abrasive, low coefficient of friction.

AVAILABLE in any ratio from 1.1:1 to 50,000:1 without increasing the number of parts. Each model has a range of reduction ratios. Overall dimensions of individual models do not change regardless of ratio.

- *7 Models*
- *.12 to 81.51 H.P.*
- *Ratios 1.1:1 to 50,000:1*
- *Max. Output Torque 50 to 113,000 in. lbs.*

Series HM Horizontal Motorized Speed Reducers are a part of the Winsmith Planetary Differential Reducer line. They feature cut-tooth helical gears of 15° helix angle for smooth, positive power transmission—greater load carrying capacity—larger reduction ratios in smaller, more compact units—minimum wear and long service life. Winsmith Horizontal Motorized Differential Reducers are easy and convenient to install, require no bedplate, deliver more horsepower per pound of weight and cubic foot of space, and permit easier integration with the driven machine.

Write today for complete information or call your nearest Winsmith Representative listed in the Yellow Pages. He is a technically trained expert who is always ready to help you with any speed reducer problem. For both standard and special power transmission applications, you'll find it pays to standardize on Winsmith.

WINSMITH, INC.

208 Eaton Street, Springville, (Erie County), New York

MEMBER OF AGMA

• • • Winsmith Speed Reducers are made by American craftsmen to meet American design and production standards.

CIRCLE 145 ON READER SERVICE CARD

CIRCLE 146 ON READER SERVICE CARD→

NOW... Design with the most paintable–durable–weldable zinc-coated steel yet produced

...NEW ARMCO

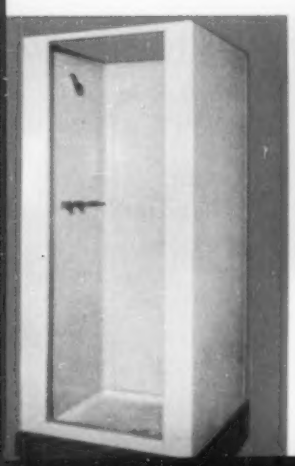
Spangle-free Armco ZINCGRIP® A, PAINTGRIP® is a zinc-coated steel especially prepared to take an ultra-smooth, lasting paint finish immediately after fabrication.

You can design for top durability. Three years of outdoor tests show paint adherence and life on ZINCGRIP A, PAINTGRIP is superior to phosphate-treated cold-rolled steel and to all zinc-coated steels prepared for painting. Its zinc coating keeps rust away when paint is damaged—protects from corrosion where there's no paint at all.

This new Armco steel is ideal for welded designs. *Twice as many spot welds* can be made as on ordinary galvanized steel before electrode tips need redressing. And it's every bit as workable as Armco ZINCGRIP, the zinc-coated steel that has proved itself in severely-fabricated products for more than a quarter-century.

New Armco ZINCGRIP A, PAINTGRIP is available *now* in gages from 16 to 24, with 1.25 oz. per sq. ft. class coating or light commercial coating, in cut lengths and coils up to 48 inches wide, depending on gage. Write for details. Armco Division, Armco Steel Corporation, 1971 Curtis Street, Middletown, Ohio.

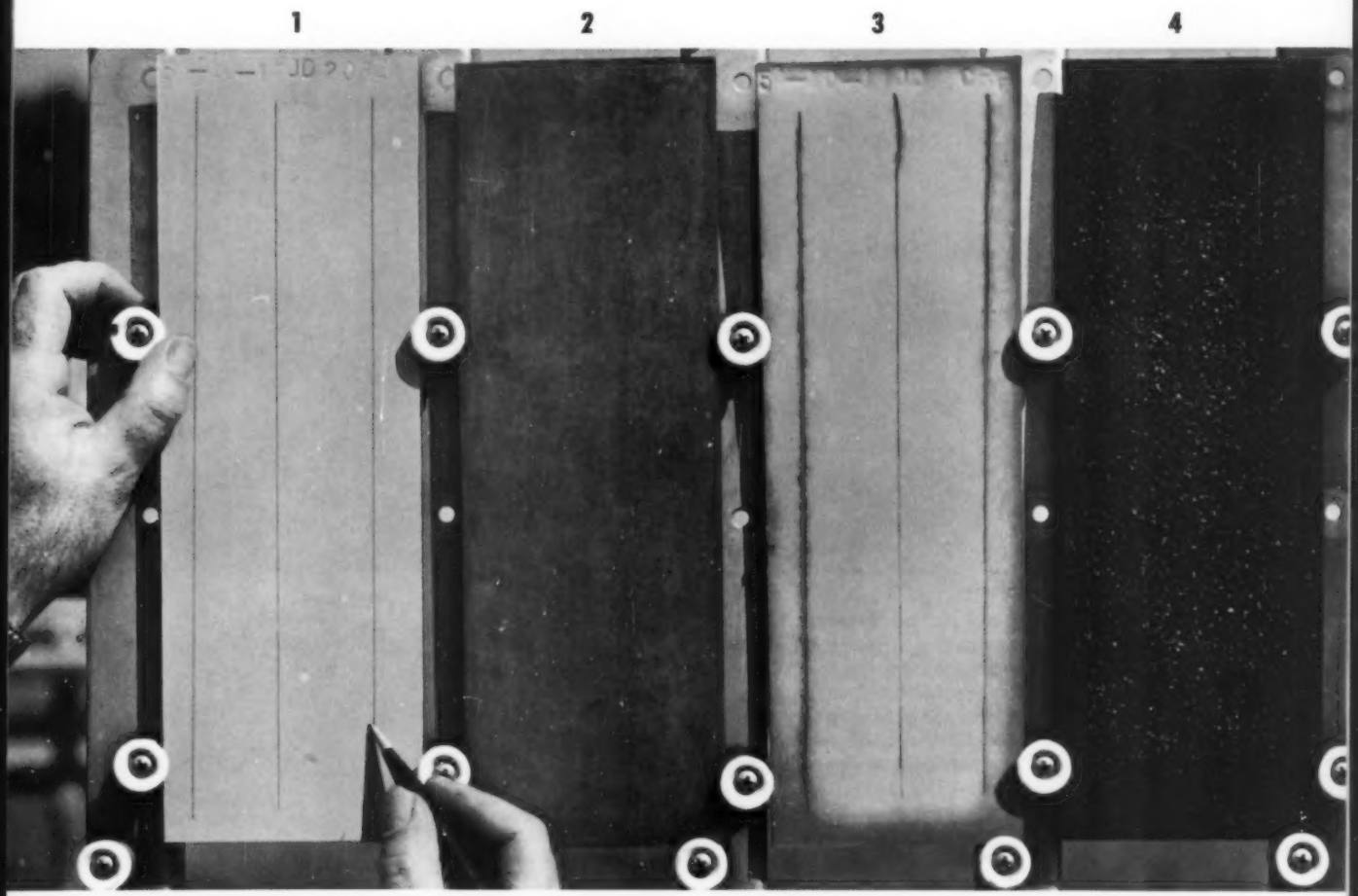
ARMCO **Armco Division**



Rust-resistance and spangle-free paintable surface mean lasting good looks in applications such as these.

New steels are born at Armco

ZINCGRIP A, PAINTGRIP



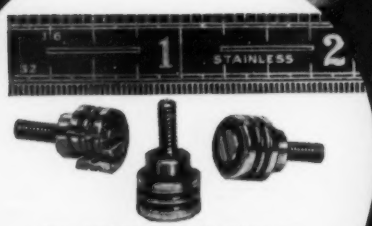
This half-painted bus body fabricated from Armco ZINCGRIP A, PAINTGRIP has been exposed for 2½ years. Paint finish is still smooth and attractive, the unpainted surface rust-free.

After 3-years' exposure outdoors, paint holds tightly to sample of Armco ZINCGRIP A, PAINTGRIP (1), even where scratched at start of test. Where unpainted (2) there's no rust either. In contrast, painted and unpainted phosphate-treated cold-rolled steel panels (3 and 4) are in poor condition. Paint has been undercut. Rust is entrenched.

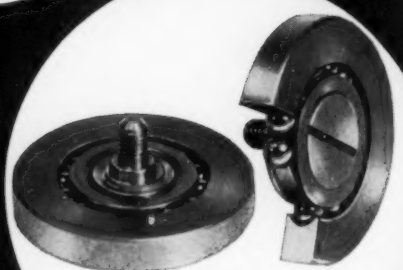
Galvanized Steel

Use this label to point out durable zinc-coated steels in your products

SPECIALISTS IN *Specials*



No. 6889-2 Guide roller on card processing business machine. Full size, as shown.



No. 7373 Feed roll idler on card processing business machine. Approximately 1½ size.

NICE "specials" provide the Product Designer with exceptional opportunities for cost reduction and product improvement. The properly designed "special" not only performs its basic bearing function, but may incorporate features that simplify mounting or installation, or combine several components into a single interchangeable "package" unit.

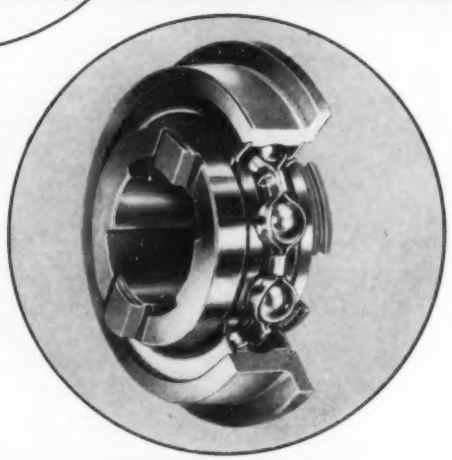
Almost six decades of bearing experience have given NICE an unusual background of experience in the field of "specials". Hence, NICE engineers are well qualified to design bearings that will fulfill particular application requirements . . . economically and efficiently.

Can NICE help you?

NICE

NICE BALL BEARING CO.

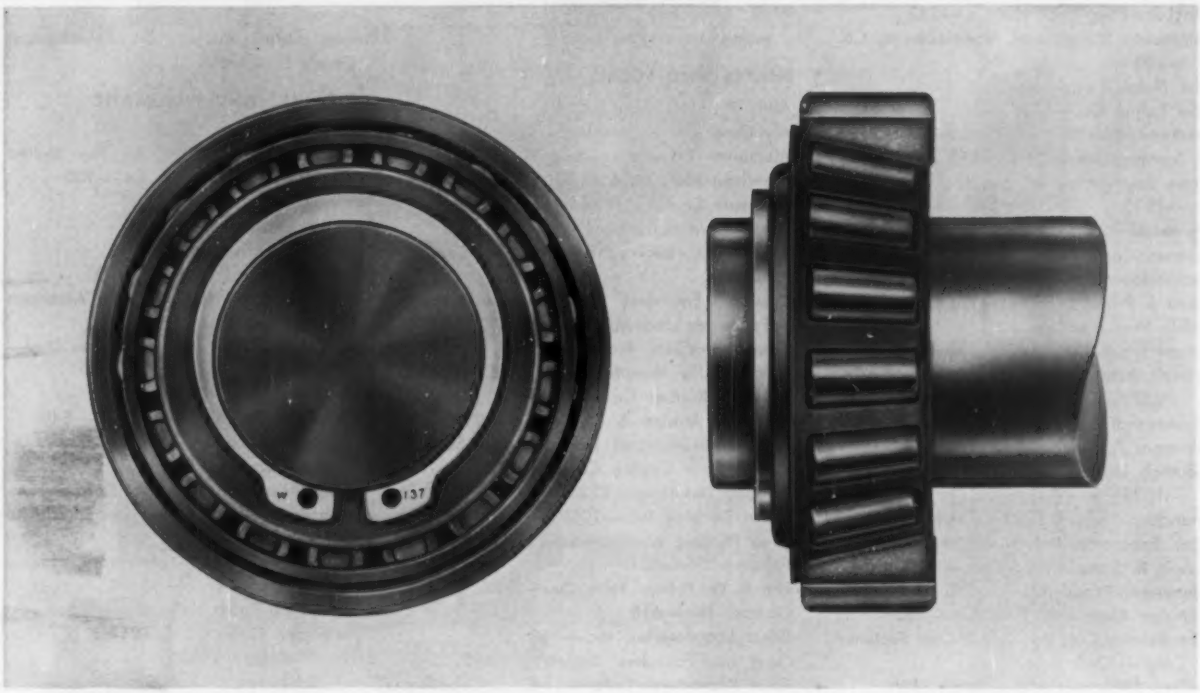
NICETOWN • PHILADELPHIA • PENNSYLVANIA



No. 7233-2 Pully bearing in clutch assembly of automatic washer. Approximately full size.

VISIT NICE BOOTH NO. 1060, DESIGN ENGINEERING SHOW, DETROIT, MAY 22-25TH

NEW! Waldes TRUARC Series 5160 Heavy-Duty Retaining Ring



for thrust and impact...for retaining bearings ...for a new approach to heavy-duty fastening

Now you can enjoy the benefits of a truly heavy-duty fastener — with all of the advantages and production economies retaining rings provide. The new Truarc Series 5160 is a unique external ring designed to secure components on shafts, axles and similar structural members. It has high thrust load and impact resistance and forms a shoulder sufficiently high to retain parts having large corner radii or chamfers. The Series 5160 is ideal for retaining bearings. You can use it *without spacer washers* to secure ball bearings, tapered roller bearings (shown above) and cylindrical roller bearings — all having large corner breakouts. The ring eliminates the need for machined shoulders, costly heavy-duty nuts and other bulkier and more expensive fastening devices normally required for extreme loading conditions. The Truarc Series 5160 is available in 11 popular sizes for shafts ranging from .473" to 2.0" dia. — and other sizes are on the way. You can order the Series 5160 in carbon spring steel or — for corrosion resistance and high temperature limits — in Armco PH 15-7 Mo stainless steel. Sizes up to 1.378" also are available in beryllium copper. For complete specifications, write for Truarc Data Bulletin No. 459-11. Better yet, contact your local Truarc Representative or Distributor. They're listed in the Classified Telephone Directory under "Retaining Rings" or "Rings, Retaining."

SEE FOR YOURSELF — Send for a free sample of the Truarc Series 5160 Heavy-Duty ring. We'll include a standard external ring of the same size for comparison. You'll see the difference as soon as you open the envelope!

WALDES KOHINOOR, INC.

47-16 Austel Place, Long Island City 1, New York 61-1

WHO'S SHOWING WHAT . . . by product

Heli-Coil Corp.—1043
Illinois Tool Works—844
Keystone Bolt and Nut Corp.—1010
The Lamson & Sessions Co.—140
MacLean-Fogg Lock Nut Co.—242
Minnesota Mining and Manufacturing Co.—550
The Nylok Corp.—440
The Palnut Co.—115
Parker-Kalon Div. of General American Transportation Corp.—451
Penn Engineering & Manufacturing Corp.—1213
Permacel—212
Ramsey Corp.—1215
Raybestos-Manhattan, Inc.—918
Reed & Prince Manufacturing Co.—1220
Robin Products Co.—103
Rosan Inc.—337
Russell, Burdsall & Ward Bolt and Nut Co.—937
Shakeproof Div., Illinois Tool Works—844
Simmons Fastener Corp.—957
Southco Div., South Chester Corporation—1021
Standard Pressed Steel Co.—815
Star Expansion Industries Corp.—331
Edwin B. Stimpson Co., Inc.—1100
Tinnerman Products, Inc.—345
Tubular Rivet and Stud Co.—350
The Uclinite Co., Div. United-Carr Fastener Corp.—1240
United Shoe Machinery Corp.—400
Waldes Kohinoor, Inc., Truarc Retaining Rings Div.—1013
Weckesser Co.—100
Wittek Manufacturing Co.—526

FINISHES AND COATINGS

Aluminum Co. of America—721
American Nickeloid Co.—1042
American Smelting & Refining Co.—711
Avery Label Co., A Div. of Avery Adhesive Products, Inc.—905
W. H. Brady Co.—321
Chemo Products, Inc.—332
Clad-Rex Div. of Simoniz Co.—309
Coating Products Incorporated—938
Columbus Coated Fabrics Corp.—525
The Dobeckmun Co., A Div. of The Dow Chemical Co.—745
Lead Industries Association—111
Marlane Development Co., Inc.—306
The Masland Duraleather Co.—944
Metal & Thermit Corp.—1125
Permacel—212
Poloron Products, Inc.—716
Poly Chem, Inc.—1138
The Polymer Corp.—1105
Rigidized Metals Corp.—1045
Roehlen Engraving Works—536
Selectrons, Ltd.—306
Shwayder Bros. Inc.—1057
Arthur Tickle Engineering Works, Inc.—1028
United Shoe Machinery Corp.—400
U. S. Stoneware Co.—919
Wall Colmonoy Corp., Stainless Processing Div.—1234

SHAPES AND FORMS

Alloy Products Corp.—221
Aluminum Co. of America—721
Aluminum Extrusions, Inc.—313
American Machine & Metals, Inc.—857
American Smelting & Refining Co.—711
The Auburn Manufacturing Co.—540
B-Mold Div., Buckeye Brass & Mfg. Co.—1032
Casting Engineers Div., Consolidated Foundries and Mfg. Corp.—450
Chemo Products, Inc.—332
Chicago-Allis Manufacturing Corp.—154
Colonial Rubber Co.—919
Conneaut Rubber & Plastics Co.—919
Continental-Diamond Fibre Corp.—156
The Decatur Casting Co.—913
Disogrin Industries—1235
Dixon Sintaloy Inc.—1059
Drop Forging Association—204
Falstrom Co.—821
The F. W. French Tube Co.—1224
Garlock Inc.—618
Glass Laboratories, Inc.—148
Gray Iron Founders' Society, Inc.—305
Gries Reproducer Corp.—1143
H P L Jersey Co.—911
H P L Manufacturing Co.—911
Hamilton Foundry Inc.—744
Haynes Stellite Co., Div. of Union Carbide Corp.—621
Hitchiner Manufacturing Co., Inc.—1025
Hunter Spring Co., A Div. of American Machine & Metals, Inc.—857
Janney Cylinder Co.—1163
Laminated Shim Co., Inc.—116
Lignum-Vitae Products Corp.—144
MM Enclosures, Inc., Affiliated with A & P Metal Products Mfg. Corp.—123
Melray Manufacturing Co.—911
Metal Powder Industries Federation—826
Mueller Brass Co.—701
National Beryllia Corp.—1134
National Tube Div., United States Steel—626
Ohio Seamless Tube Div. of Copperweld Steel Co.—811
O'Sullivan Rubber Corp.—359
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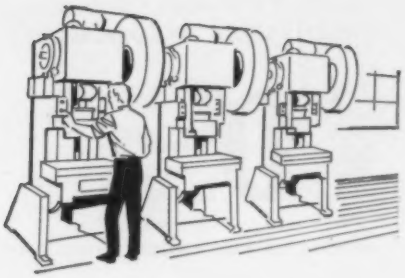

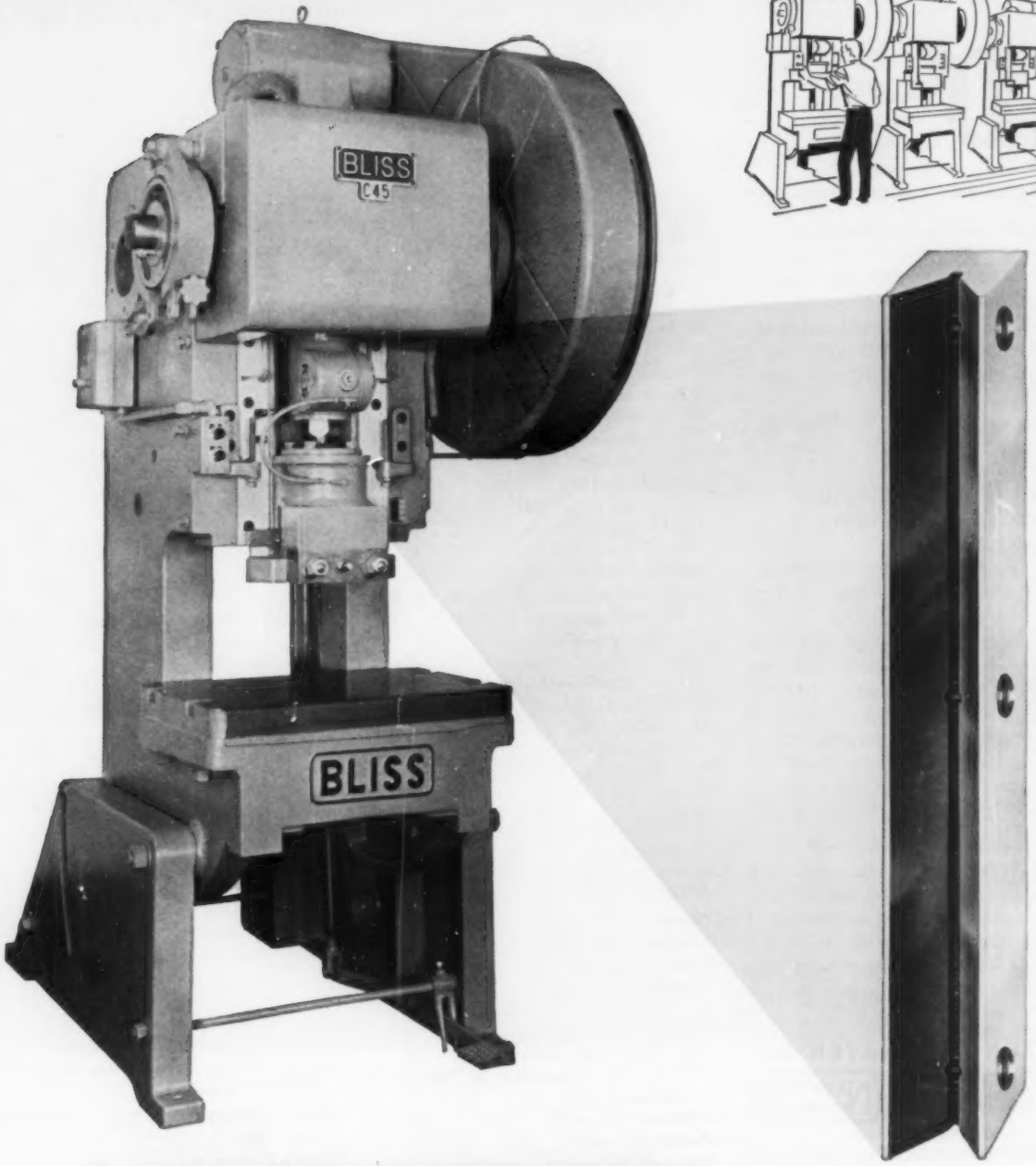

LAMINA-BRONZE
WEAR PLATES

Lamina
DIES AND TOOLS, INC.
P.O. BOX 31, ROYAL OAK, MICHIGAN
Phone JOrdan 6-8711

Lamina-Bronze Wear Plates and their use are more completely described in Bulletin WP-59, send for your free copy.

The ram guides of this Bliss press utilize Lamina-Bronze (electroplated bronze on steel) wear plates to assure long life and free-running. For all models in the "C" series of inclinable presses, Bliss has standardized on Lamina-Bronze V-Gibs. In like manner, Lamina-Bronze wear surfaces are the best answer for any part that requires the non-seizing properties of bronze and the strength of steel.

CIRCLE 151 ON READER SERVICE CARD 151

FOR DESIGNERS AND PRODUCT PLANNERS

*PDCS
*PROTOTYPE DIE CASTING SERVICE

ANSWERS ALL THESE PROBLEMS

If part of the product you are planning is to be a die casting . . . PDCS holds the solution to situations like these . . .

Your customers want samples of your product and you need die castings to complete your samples.

You must test the function of a new assembly which includes a die casting.

You are required to test the strength of a die casting as applied to your needs.

You want to judge the "feel" or appearance of a die casting before final specification.

You must hold down the cost of new product development by avoiding expensive design errors.

You are interested in market testing the sales appeal of a new product and die castings are required to build the needed samples.

PDCS is a newly developed process for creating production-like die castings, in small quantities, at low cost, without permanent tooling charges. Find out for yourself how PDCS can help you by filling out the coupon below and mailing it today.

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NEWTON NEW HAVEN

CUSTOM PRODUCERS OF DIE CASTINGS

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☐ **Prints** ☐ **Models** ☐ **Sketches are being forwarded under separate cover. Please submit your cost estimate.**
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☐ **Send me your free folder, "PDCS . . . Prelude to Production".**

A

NAME:_____
TITLE:_____
COMPANY:_____
ADDRESS:_____

1961 SHOW DESIGN

WHO'S SHOWING WHAT, by product

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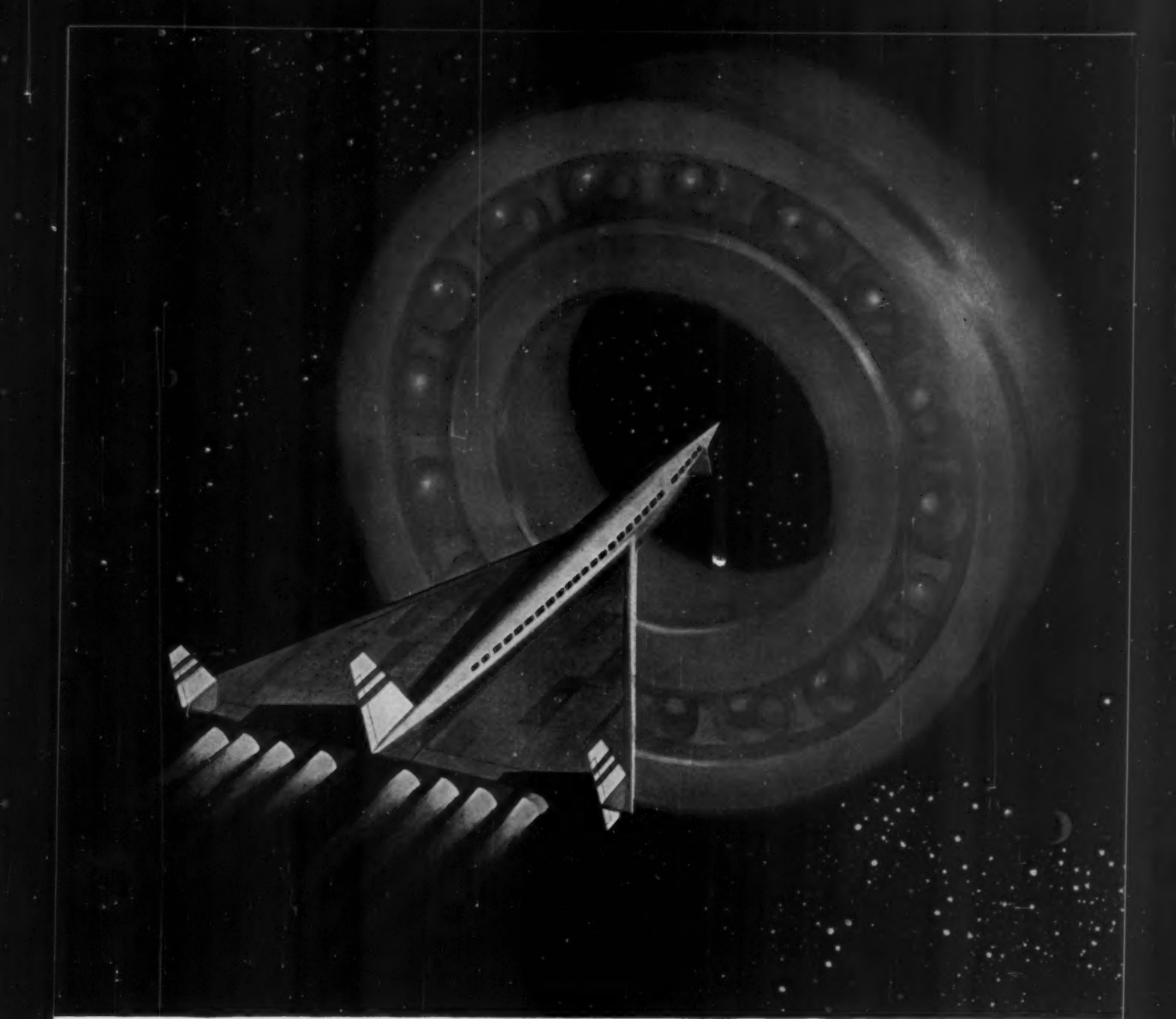


BEARING WITH A RED HOT FUTURE

SKF MOTION ENGINEERING

Advanced ball and roller bearing technology

On special test equipment in SKF's research laboratory, experimental ball and roller bearings are run at temperatures up to 1000° F and above—conditions under which steel becomes red hot and loses its strength, while conventional lubricants burn or boil away. To meet these problems, bearings made of special heat-resisting alloys and exotic new materials are tested and evaluated. New ideas in design and new approaches to lubrication are constantly being investigated.

Bearings to resist extremely high temperatures are needed for improved, high performance jet engines, gas turbines and other equipment. Special SKF bearings have been tested successfully in environments at about 1000° F. Under certain conditions of operation, much higher temperatures are practical.

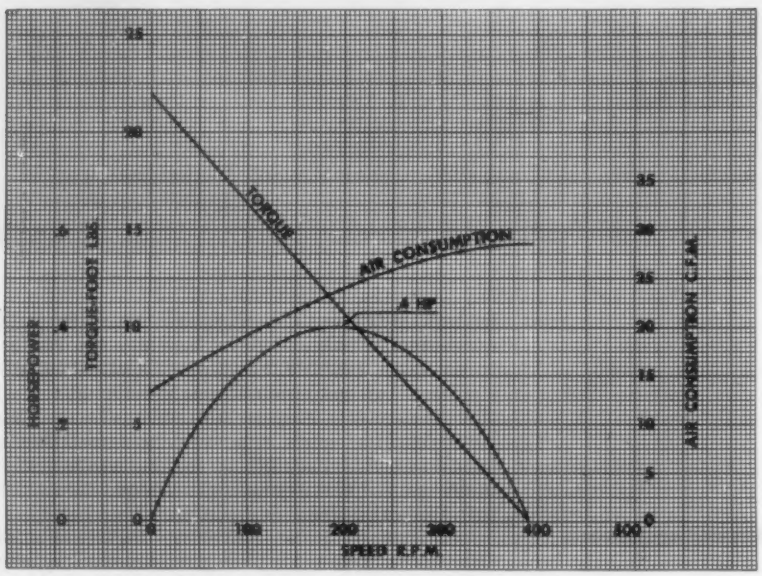
Research like this is your assurance that SKF will always keep pace with demands for the highest possible performance in all major types of rolling contact bearings —ball, cylindrical roller, spherical roller, tapered roller and precision miniature. SKF Industries Inc., Philadelphia 32, Pa. 6103

CIRCLE 153 ON READER SERVICE CARD

CLECO AIR MOTORS

can meet your design requirements from inch-ounces to hundreds of foot-pounds!

- More power, less weight.
- Torque control—stall or automatic.
- Right or left hand rotation, reversible or non-reversible.
- Explosion proof.
- Standard parts replacement from nation-wide CLECO Service Centers.



Example motor performance chart

TECHNICAL DATA:
Motor Performance Charts available to help you with production problems.

For complete information, call or write

CLECO AIR TOOLS

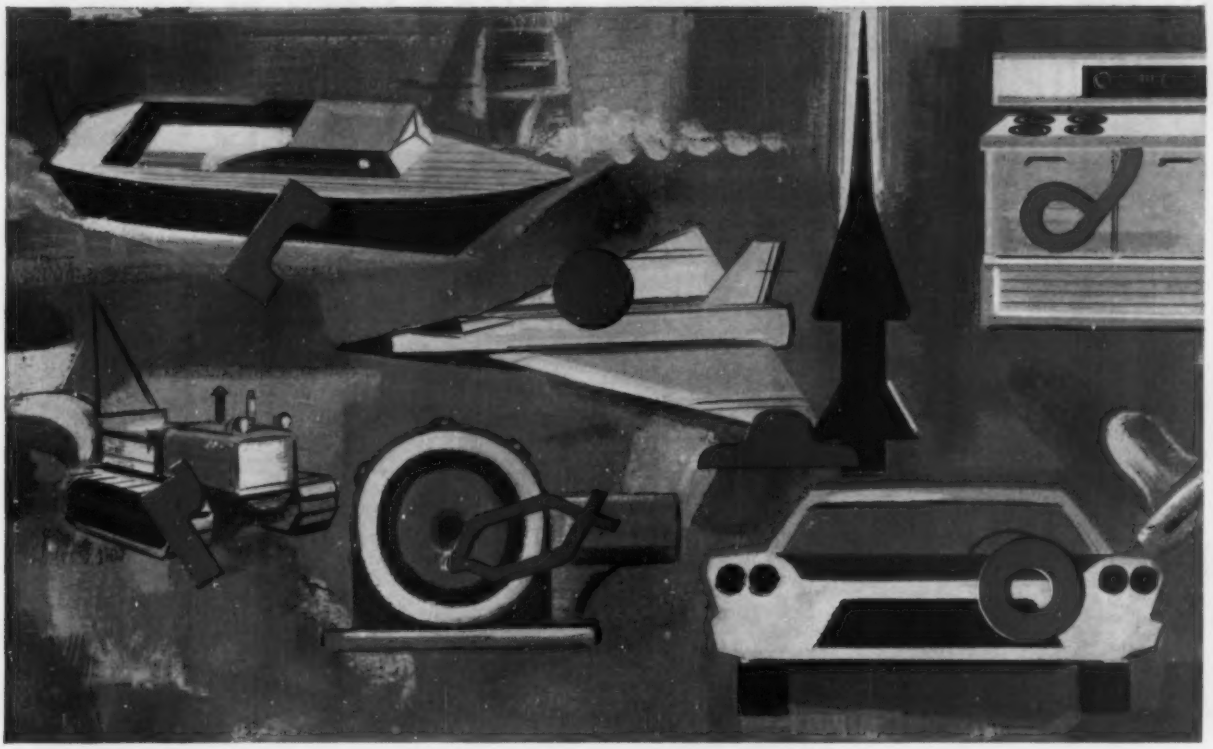
"quality tools engineered for industrial progress"

A Division of Reed Roller Bit Company • P. O. Box 2541/Houston 1, Texas, U. S. A.

IN CANADA: Cleco Pneumatic Tool Company of Canada, Ltd., 927 Millwood Road, Leaside (Toronto), Ontario

SILICONE NEWS from Dow Corning

Design For Quality



SILASTIC Assures Trouble-Free Operation, Builds Lasting Brand Preference

Tomorrow's customers will demand quality. They'll demand trouble-free operation. They'll demand lasting durability. You'll have to meet these demands to maintain any kind of profit margin. Improvements in the design of your products will help. But more important in your *quality mix* is the selection of better, more dependable materials . . . materials like Silastic®, the Dow Corning silicone rubber.

Because Silastic is doing so many difficult jobs well, designers no longer challenge Silastic's immunity to deterioration by 500 F heat, —130 F cold, weathering, ozone, corona, and oxidation aging. Today's designers concentrate on making the most efficient use of the properties of Silastic to increase consumer satisfaction with products like frypans, automotive transmissions, range doors, tire valves . . . even baby bottle nipples. Thanks to Silastic, the rubber that never grows old . . . never gets tired . . . many of tomorrow's products will last longer, perform more efficiently, cost less to maintain. Will yours?

Over 100 Rubber companies manufacture these standard parts from Silastic:

- **Seals and Gaskets**
- **O-Rings**
- **Mechanical Rubber Goods**
- **Coated Fabrics**
- **Ducting and Hose**
- **Extrusions**
- **Sleeving**
- **Electrical Tapes**
- **Sponge**
- **Wire and Cable**

For more information about Silastic and list of parts suppliers, write Dept. 7217.

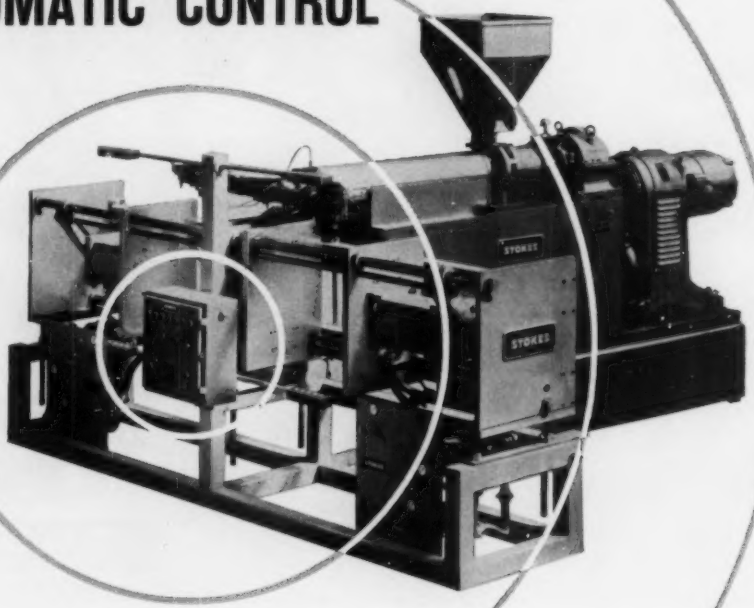
first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

CIRCLE 155 ON READER SERVICE CARD 155

AN INDUSTRIAL TIMER FOR AUTOMATIC CONTROL



At the heart of the new, high capacity STOKES BLOW MOLDER

The production of hollow plastic articles (containers, dispensers, etc.) has been boosted immeasurably with the development of "High Capacity Stokes Dual - Manifold Blow Molder".

And at the heart of the system is an Industrial Timer Corporation timing device to provide the precise control of each cycle of processing.

Wherever precise timing controls are required in industrial processes, or in equipment, Industrial Timer Corporation has the wide range of instruments, the wide experience in applying them, that assure the perfect answer to your problem.

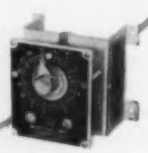
If timing is of the essence . . . take the time to consult an Industrial Timer expert.

Phone or write us.

RUNNING TIME METERS

RECYCLING TIMERS

INTERVAL TIMERS



TIMER DELAY TIMERS

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION

1403 McCarter Highway, Newark 4, New Jersey

Manufactured and sold in Canada by
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CIRCLE 156 ON READER SERVICE CARD

NEW!
RED RING PRECISION GEAR HONER

Smaller

More Compact

Lower Cost

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MANUAL LOADING

Your choice of 4 Honing Methods

SPUR AND HELICAL GEAR SPECIALISTS
ORIGINATORS OF ROTARY SHAVING,
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NATIONAL BROACH & MACHINE CO.

5600 ST. JEAN • DETROIT 13, MICHIGAN

WORLD'S LARGEST PRODUCER OF GEAR SHAVING EQUIPMENT

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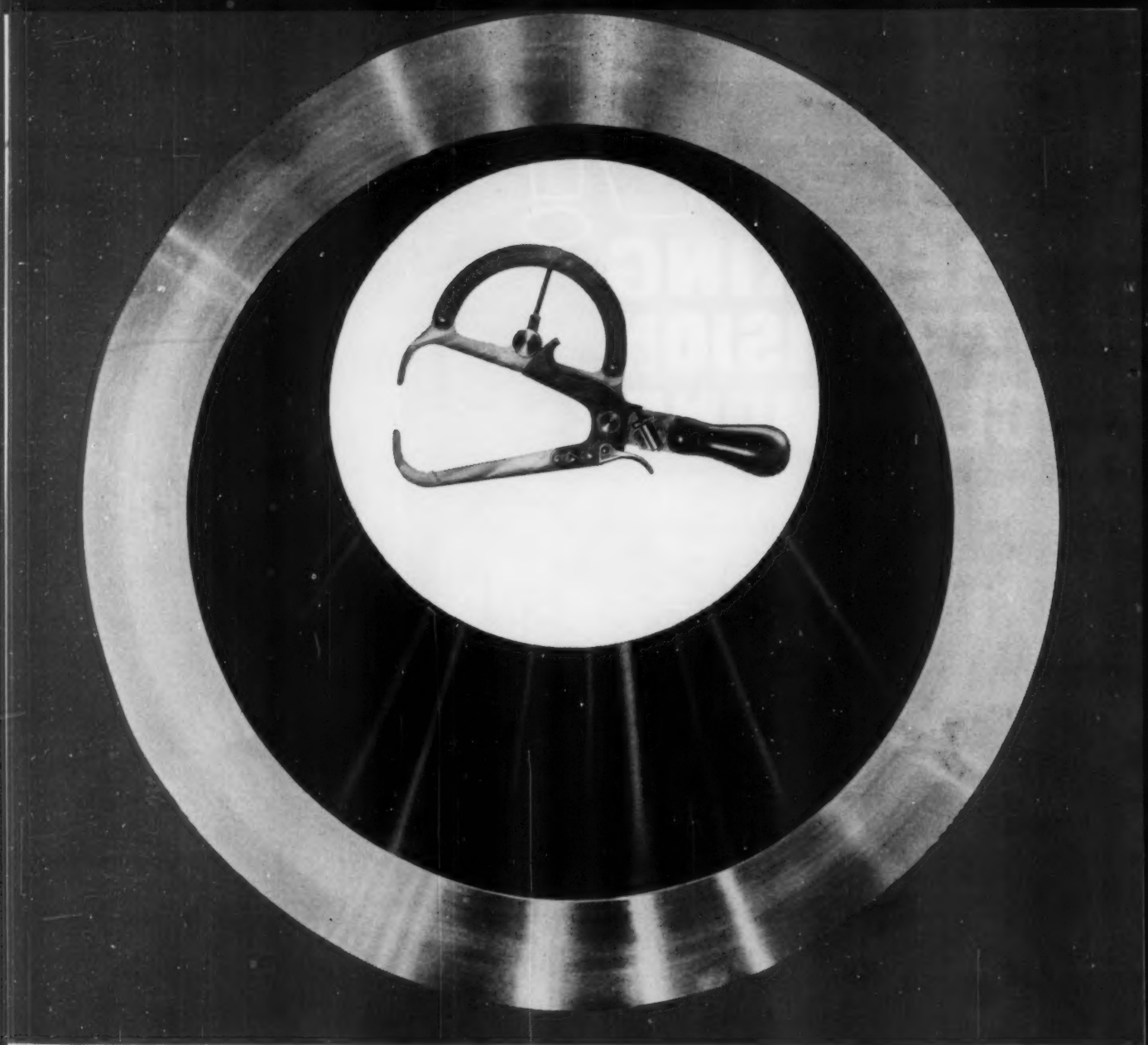


NEW SIZE RANGE SURPRISE!

HERE'S A NEW PROCESS in centrifugally spun tubing that offers you greater freedom in design. It's ACIPCO CERAM-SPUN®... the new ceramic mold process* that is not limited by equipment sizes!

NOW, YOU CAN ORDER almost any combination of sizes you require. ACIPCO CERAM-SPUN® tubes offer O.D.'s from 2.25" to 50"; and wall thicknesses from .25" to 8". As-cast lengths are furnished from 4 feet to 20 feet, longer lengths are made by welding.

THINK OF HOW MUCH this process can save you! You'll avoid the cost of unnecessary metal waste, and excessive machining charges. And ACIPCO's complete "under one roof" operations — including heat treating, machining and welding — offer many additional economies. No need for the delays and excessive costs that often result in buying from multiple sources.

If you design, manufacture or use tubular component parts, it will certainly pay you to investigate the versatility of ACIPCO CERAM-SPUN® tubing and the flexibility of ACIPCO's integrated facilities. Contact **ACIPCO STEEL PRODUCTS,** Division of American Cast Iron Pipe Company, Birmingham 2, Alabama.

*Patent applied for

ACIPCO CERAM-SPUN®
STEEL TUBING

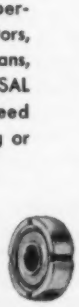
FOUR NEW **UNIVERSAL** ELECTRIC FRACTIONAL H.P. MOTORS

featuring Free-Aligning bearings —either sleeve or ball

UNIVERSAL ELECTRIC

Type 23 4 pole sleeve bearing
Type 63 6 pole sleeve bearing
Type 523 4 pole ball bearing
Type 563 6 pole ball bearing

Primarily because of their new bearing assemblies (free aligning sleeve or free aligning ball), these four new UNIVERSAL motors operate at a reduced noise level, start easier and assure an extremely long operating life. They insure maximum performance and efficiency for kitchen ventilators, unit heaters, evaporative coolers, condenser fans, refrigerated cabinets, etc. These UNIVERSAL ELECTRIC motors also offer the perfect flat speed torque curve necessary for critical air moving or recorder applications.

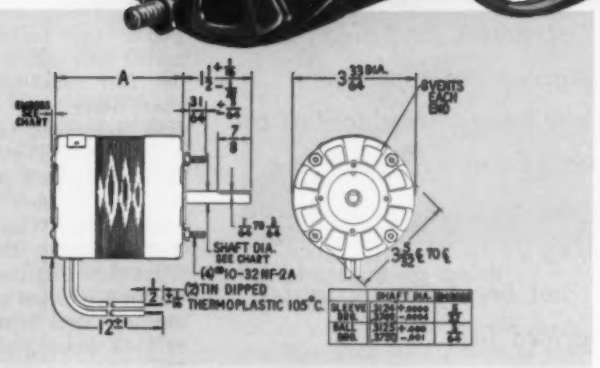


UNIVERSAL Ball Bearing Assembly is resiliently suspended in a neoprene collar confined in small metal clips that allow free movement along bearing support surface. With axis of support at its center, bearing can adjust to any shaft misalignment. Advantages: reduced noise level, easier starting, no snap rings or shoulders or undercuts for stronger motor shaft, no pre-loaded bearings due to misalignment for free-running motor, longer motor life.

UNIVERSAL Sleeve type bearing eliminates fhp motor bearing problems due to misalignment. Like ball bearing assembly, sleeve bearing is inherently in balance; can adjust to any shaft misalignment 100% of the time under any load conditions.

SPECIFICATIONS

Shaft Diameter—5/16 or 3/8 inches
Mountings—4 point on $2\frac{27}{32}$" or $3\frac{5}{32}$" (either end of motor)
Either Fan or Mechanical Duty; Internal Fan Available
All Angle Operation
Cases—Drawn steel, formed and embossed for maximum rigidity, compact, rugged design
Rotor—Diecast and machined to precision tolerances
Dual and Three Speed Windings
115 or 230 volt, 50 or 60 cycle
Totally Enclosed Types Available
Complies with CSA and U/L Requirements



4 POLE SPECIFICATIONS

Model				Watts	Amps.	
Sleeve	Ball	H.P.	Speed	Input	Input	"A"
23E6	523E6	1/50	1550	65	0.8	$2\frac{15}{32}$
23E8	523E8	1/35	1550	80	1.0	$2\frac{23}{32}$
23E10	523E10	1/25	1550	105	1.4	$2\frac{31}{32}$
23E12	523E12	1/15	1550	165	2.2	$3\frac{7}{32}$
23E14	523E14	1/12	1550	210	3.0	$3\frac{15}{32}$

6 POLE SPECIFICATIONS

Model				Watts	Amps.	
Sleeve	Ball	H.P.	Speed	Input	Input	"A"
63E6	563E6	1/60	1000	75	1.0	$2\frac{15}{32}$
63E8	563E8	1/40	1000	95	1.3	$2\frac{23}{32}$
63E10	563E10	1/30	1000	125	1.7	$2\frac{31}{32}$
63E12	563E12	1/20	1000	175	2.3	$3\frac{7}{32}$
63E14	563E14	1/15	1000	230	3.1	$3\frac{15}{32}$

Write for complete specifications on your requirements.

UNIVERSAL ELECTRIC COMPANY

PRECISION ELECTRIC MOTORS

EXECUTIVE AND GENERAL SALES OFFICES: OWOSSO, MICHIGAN, DEPT. 12

54

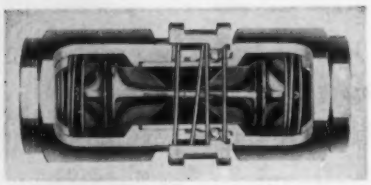
←CIRCLE 158 ON READER SERVICE CARD

CIRCLE 159 ON READER SERVICE CARD 159

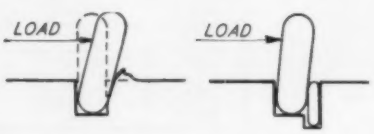
SIGNIFICANT COMPONENTS MATERIALS, PROCESSES

These mechanical components, electrical devices, fluid power and control systems, materials of construction, and aids for the engineering department are being introduced at the 1961 Design Engineering Show, Cobo Hall, Detroit, May 22 to 25, and have not been previously described in

PRODUCT ENGINEERING

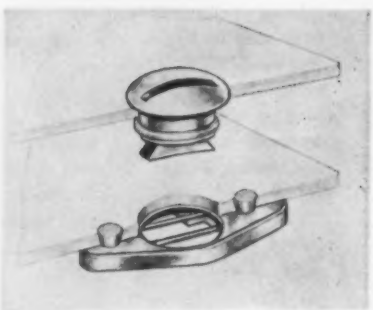


Two-way shutoff coupling . . .
for large-capacity fluid lines reportedly does not leak, or spill gas or liquid, when disconnected, or spurt fluids when connected. During disconnection, identical guided valves in both socket and plug contact valve seats to provide instant shutoff. This shutoff takes place in brief instant before plug completely separates from socket and before socket's O-ring seal is broken. During connection, socket O-ring completely seals coupling before valves release flow of fluid from both sides of line. With coupling connected, fluid flows freely through it and O-ring is compressed against plug's inserted outside surface to seal against leakage. Available from stock in steel or brass with 1¼- or 1½-in. female pipe thread connections. **Hansen Mfg Co, 4031 W 150th St, Cleveland 35.** See Booth 512 or
Circle 300 on Reader Service Card

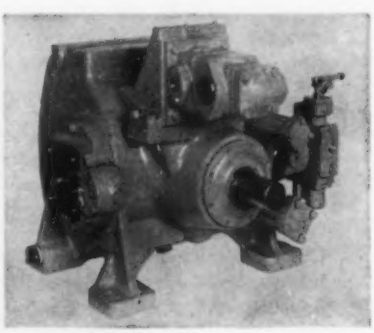


Back-up ring . . .
for retaining rings is thin, single-turn wound ring that distributes force across groove wall to increase thrust capacity of retaining ring as much as two times. Back-up ring fits entirely within groove but requires wider and deeper groove. **Ramsey Corp, PO Box 513, St Louis 8.** See Booth 1215 or
Circle 301 on Reader Service Card

Three adhesives . . .
are for structural, contact bond and printed circuit uses. Structural thermosetting film adhesive needs only enough pressure to provide contact and to keep parts properly aligned. Metal-to-metal shear strength exceeds 4000 psi at 75 F. Contact bond adhesive may be sprayed on parts before assembly operation. Later, momentary pressure with hammer or nip roll effects bond. Printed circuit adhesives bond copper foil to phenolic or epoxy-impregnated base stock, phenolic and epoxy papers or epoxy glass materials. **Minnesota Mining & Mfg Co, 900 Bush Ave, St Paul 8.** See Booth 550 or
Circle 302 on Reader Service Card



Miniature fastener . . .
for electronics applications where space and weight are limited, has inside projection of less than ⅛ in. Extra-thin oval head also means min outside projection. The one-piece, hardened-steel stud with all-stainless steel receptacle locks and unlocks with a quarter turn each. No special holes or special tools are required for installation. All loads are carried by solid supports. **Simmons Fastener Corp, North Broadway, Albany 1, NY.**
See Booth 957 or
Circle 303 on Reader Service Card



Piston pumps . . .
for high-pressure applications and power package with 10-gal-capacity reservoir, make debut. In-line piston units are initially available in 5- and 10-gpm sizes

(at 1800 rpm) with either fixed or variable displacement and are rated at 1500 psi continuous and 3000 psi intermittent. Over-all efficiency of 85% at 1800 rpm and 1500 psi allows pumps to operate with min temperature rise and correspondingly low hp loss. Variable delivery piston pumps (illustrated) are rated at 3000 psi continuous and 5000 psi intermittent, compared with 2000 psi and 3000 psi, respectively, for previous models. Over-all efficiency at 1200 rpm and 5000 psi is approx 94%. Max displacement is 23.71 cu in. per revolution, and delivery is 120 gpm at 1200 rpm with atmospheric inlet pressure. Other power units scheduled for release include 20-, 40- and 80-gal. sizes. Complete package includes electric motor in sizes up to 40 hp; variable delivery vane pump in sizes up to 60 gpm; relief valve; and reservoir. Internal baffling provides long return path which is said to improve heat dissipation and purge oil of any trapped air. **Vickers Inc, Div of Sperry Rand Corp, Detroit 32.**

See Booth 549 or
Circle 304 on Reader Service Card

Vinyl-clad aluminum sheet . . .

is suitable for high-speed volume fabrication and can be drawn, roll-formed, corrugated, punched, embossed, crimped and expanded. Produced in widths up to 48 in. and thicknesses from 0.016 to 0.051 in., the lamination is available in all sheet forms, including coils, flats, circles and blanks. Wide application is expected in consumer durable, transportation and building industries. Can be supplied with any one of 39 "exclusive" vinyl color-pattern variations or with any commercially available vinyl plastic. **Aluminum Co of America, 1501 Alcoa Bldg, Pittsburgh 19.** See Booth 721 or
Circle 305 on Reader Service Card

Self-retaining plastic fastener . . .

is installed in two steps—placing fastener in hole and pushing with simple tool. Fastener pulls up and provides tight, vibration-free lock because of toggle action of radial webs opening out (called "sunburst" principle). Only one piece, it can be installed and locked from one side, making it suitable for blind assemblies. Principle can be applied to nylon trim or moulding retainers or to wire straps, tubing retainers and other assembly fasteners in polypropylene, nylon or similar materials. **Robin Products Co, 27027 Groesbeck Hwy, Warren, Mich.**

See Booth 103 or
Circle 306 on Reader Service Card

Four valves . . .

include precision servo and control units. Single-stage servovalve is rated at 3 gpm with 350-psi pressure drop and combines ruggedness with high-performance (90° phase shift at 200 cps). High-force torque motor directly activates spool. Miniature directional control valve (illustrated) is offered as 4-way unit in both single- and double-solenoid models. Designed for small-volume systems used in jig positioning and clamping, hydraulic gear shifting and clutching on machine tools, etc., this unit operates to 1000 psi and has max capacity of 2 gpm. Providing electrical means for selecting any one of a number of feed rates is job of remote flow control valve. Requires 3-w power input and is available with either of two flow ranges: 0 to 250 $in.^3$/min. or 50 to 1000 $in.^3$/min. Spool is positioned by torque motor similar to that used in servovalve. Repeatability of flow settings reportedly can be obtained within less than 1%. Deceleration valve is a gasket-mounted unit for controlling deceleration of a worktable, machine slide or other such linear action with mechanical cam actuation. It is rated for flows to 12 gpm. **Vickers Inc, Div of Sperry Rand Corp, Detroit 32.**

See Booth 549 or
Circle 307 on Reader Service Card

Oil seal . . .

with filled Teflon sealing element, has been tested to 3000 fpm without wearing or scoring shaft. A steel shell encloses and positions gasket holding sealing element tightly against shaft. **Garlock Inc, 250 Main St, Palmyra, NY.**

See Booth 618 or
Circle 308 on Reader Service Card

Clutches and brakes . . .

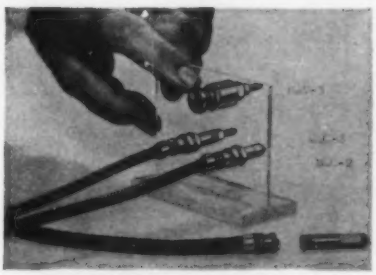
include a stationary-field clutch, rated at 50 lb-ft torque and nominally 5 in. dia. A 1350 lb-ft clutch, approx 15 in. dia, is offered with spline-drive armature and requires a special control. Fractional-hp clutch-brake has torque ratings of 8, 60 and 240 lb-in. Unit may be direct-coupled to input and output drives or may use sheave, gear or sprocket on input and output shaft extensions. **Warner Electric Brake & Clutch Co, Beloit, Wis.**

See Booth 700 or
Circle 309 on Reader Service Card

Captive ¼-turn fastener . . .

is pushed into panel holes and assembled by screwdriver or fingergrip. Barrel shank centers spring-steel fastener in hole and adds shear resistance. Lightweight, light-duty applications are suggested. **The Palnut Co, Div of United-Carr Fastener Corp, Mountainside, NJ.**

See Booth 115 or
Circle 310 on Reader Service Card



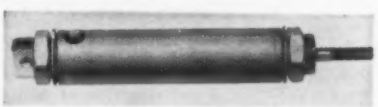
Panel-mounting quick connects . . .

for air circuitry, have internal check to stop flow when front portion of coupler is disconnected. Various back connections include female 10-32 port to take metal or flexible tube fittings. Quick disconnect for clamp mounting or miniature air manifold has 10-32 male thread. **Clippard Instrument Lab, 7390 Colerain Rd, Cincinnati 39.** See Booth 1013 or
Circle 311 on Reader Service Card

Capped washer-base nut . . .

with either self-threading or self-locking threads is made of spring steel. Acorn head covers bolt ends. Also available with integral seal washer to keep out dirt and water. **The Palnut Co, Div of United-Carr Fastener Corp, Mountainside, NJ.**

See Booth 115 or
Circle 312 on Reader Service Card

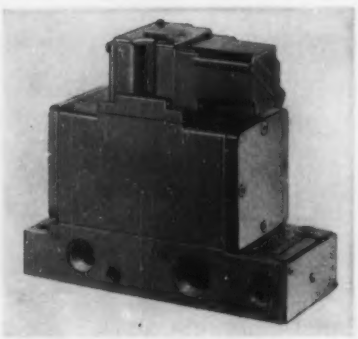


Air-hydraulic cylinder . . .

with ⅞-in. bore is for 250-psi air and 2500-psi hydraulic service. Has 1-in. stroke spring return and is available in 1-, 2-, 3-,

continued on page 162

5-, 7- and 9-in. double-acting models. Piston area is 0.6 sq in., giving 60-lb output force at 100 psi and 1500 lb at 2500 psi. All parts and seals are replaceable. Cylinders stud mount front or rear, clevis mount rear or foot mount with nuts and lockwashers supplied. Internal cushions are Buna-N. Shaft extension is 1 in., threaded ¼-28 x ¾ in. Ports are standard ¼ NPT. From stock at approx $16 to $19 depending on stroke. **Clippard Instrument Lab Inc, 7390-P Colerain Rd, Cincinnati 39.** See Booth 1013 or
Circle 313 on Reader Service Card



4-way, pilot-operated air valve . . .

has 15 to 150-psi working capacity. Special chamber assures adequate volume of reserve pilot air at line pressure to shift valve despite momentary drops in air supply. Takes ½-in. valve 0.029 sec after signal to fill a 12-cu in. load chamber from 0 to 90 psi (100-psi supply) and 0.075 sec to fill 100-cu in. load chamber. Time required to exhaust is correspondingly fast. Comes in both momentary- and maintained contact-electrical actuation models and in ⅜-, ½- and ¾-in. pipe sizes with side ported bases as standard. **Hannifin Co, Div of Parker-Hannifin Corp, Des Plaines, Ill.** See Booth 544 or
Circle 314 on Reader Service Card

Variable-speed hydraulic drive

is 4-hp transmission that has no-load max speed of 1800 rpm. Hydraulic motor can be mounted in three different positions on either side of hydraulic pump (total of 6 positions), and foot mounting can be rotated 180°. Speed and direction of motor are controlled by varying pump displacement with either a handwheel, mechanical lever or remote electrical control. **Vickers Inc, Div of Sperry Rand Corp, Detroit 32.**
See Booth 549 or
Circle 315 on Reader Service Card

Pulse-producing switch . . .

has adjustable pulse length of 0.030 to 0.450 in. and adjustable operating plunger which can be extended 0.750 in. Controls pneumatic valves where permanent-duty solenoids are not used. Entire pulse operation occurs as plunger is depressed. There is no switching action on return stroke. SPDT basic unit carries 10 amps at 125, 250, or 480 v ac; ½ amp at 125 v dc; and ¼ amp at 250 v dc. Pretravel is 0.150 in. max; total plunger travel, 0.600 in. min; operating force, 4 lb max; and full overtravel force, 8 lb max. **Micro Switch Div, Minneapolis-Honeywell Regulator Co, Freeport, Ill.**
See Booth 1211 or
Circle 316 on Reader Service Card

Precision-moldable insulation material . . .

is a ceramoplastic that operates to 1200 F and can be molded to complex shapes with gage-like tolerances. Retains insulation resistance at elevated temperatures (at 932 F, volume resistivity is 10^8 ohm-cm) and matches many metals in thermal expansion factor. In ASTM tests has shown 0.020 loss factor at 1 megacycle; arc resistance of 300 sec; and dielectric strength of 270 v/mil. Said to have total dimensional stability, even under adverse thermal cycling, and an indefinite shelf life. Also impervious to oil, water, humidity and organic solvents. **Mycalex Corp. of America, 30 Rockefeller Plaza, New York.**
See Booth 1063 or
Circle 317 on Reader Service Card

Temperature controller . . .

handles two standard ranges with a change in sensing units. One sensor allows a range from 0 to 450 F; another from 450 to 800 F. Instrument's contact rating is 15 amp SPST at 115 or 230 v ac. Slide switch changes voltage rating to match supply. If heated mass and power input are properly balanced, accuracy to within 2 F is normal. In event sensor leads become broken, control circuit "fails safe." Available panel mounted as a single or multiple point instrument with features added or deleted. **Electro-Flex Heat Inc, 83 Woodbine St, Hartford 6, Conn.**
See Booth 112 or
Circle 318 on Reader Service Card

10,000-psi double-acting cylinders . . .

for continuous "pushing" and "pulling," come in capacities of 50, 75, 100 and 150 tons and bore sizes of 2¾, 4½, 5⅛ and 6⅞ in. Stroke length is on request. Have heat-treated alloy steel piston rods, tie-rods and nuts; heavy-wall cylinder shells; metallic rod wipers; and self-adjusting flange-type rod seals. **Precision Hydraulics Div, Owatonna Tool Co, 727 Cedar St, Owatonna, Minn.**
See Booth 1203 or
Circle 319 on Reader Service Card

Heavy nylon castings . . .

up to 6 lb are available. Short-run process makes use of higher viscosity nylon (said to have improved physical properties) than otherwise can be used; yet there is almost no limitation on cast-in inserts, threads, lugs, intricate shapes or varying thicknesses. **Nylon Molded Products Corp, Garrettsville, Ohio.**
See Booth 125 or
Circle 320 on Reader Service Card

Needle thrust bearing . . .

uses a glass fiber-filled nylon retainer to reduce sliding friction usually found in all-steel type bearings. Use of nylon also is said to lessen retainer wear. Bearing's thrust capacity is reportedly equal to or greater than capacity of all-steel bearing and permissible operating speeds are greater. Operates at a lower temperature by having lower heat conductivity and less

continued on page 164

A T-Marked SPEED NUT Brand Fastener...

SPEED CLAMPS® go on fast, trim weight and parts handling

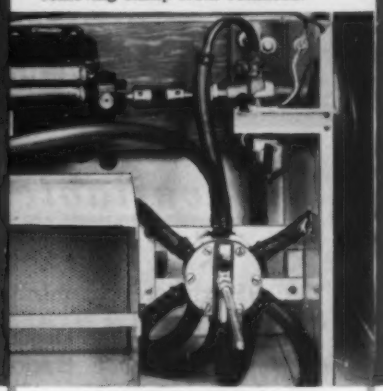
Attachment of tubing is fast and simple with vibration-proof Tinnerman SPEED CLAMPS. They are available in a wide range of sizes and types, with or without attached SPEED NUTS or neoprene flame-resistant cushions. They make firm, secure attachments and allow substantial savings in weight, assembly time and costs.

The complete line of Tinnerman SPEED CLAMPS includes hose clamps, tube clamps, harness clamps, and an assortment of special types to meet various requirements.

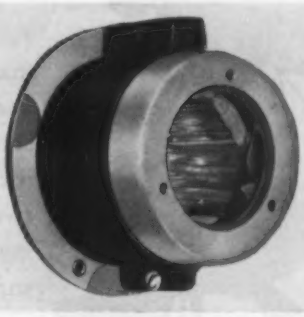
When buying clamps or spring-steel fasteners, look for the T-mark...your assurance that you're putting Tinnerman quality and total reliability into your products. For samples, literature, prices call your local Tinnerman Sales Office . . . listed in the "Yellow Pages" under "Fasteners." Or write to: *Tinnerman Products, Inc., Department 12, Box 6688, Cleveland 1, Ohio.*

T-MARK ENGINEERED SPECIALS

TIME SAVING was the benefit when this Tinnerman Harness Clamp was used to fasten wire bundles to an aircraft structure. Inset shows safe, interlocking tongue and slot that can't spring open accidentally, yet opens readily for servicing without removing clamp from bulkhead.



ASSEMBLY SIMPLIFICATION resulted from a switch to Tinnerman Hose Clamps in this oil changer. One-piece SPEED CLAMPS are easy to apply, quickly secured with standard pliers. Savings in time and labor are substantial, excessive weight and parts handling are eliminated.



GREATER RELIABILITY is attained by television manufacturers with Tinnerman Deflection Yoke Clamps. They eliminate the problem of misalignment and broken connections resulting from rough handling, cushion the tube assembly under live spring tension.

TINNERMAN *Speed Nuts*®
Look for the Tinnerman "T"

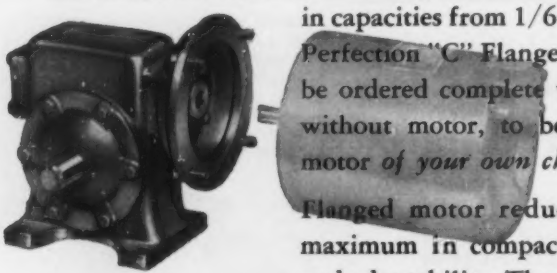
CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S.A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano Simmonds GMBH, Heidelberg.

956

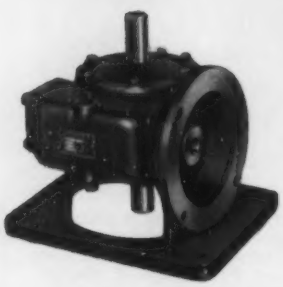
different
motorized
speed reducers

available from stock

Yes! 956 different combinations of Perfection Motorized Worm Gear Speed Reducers are available for immediate delivery, *from stock*. Ratios range from 5 to 1 to 60 to 1, in capacities from 1/6 H.P. to 5 H.P. Perfection "C" Flange Reducers may be ordered complete with motor or without motor, to be used with a motor *of your own choice.*



Flanged motor reducers offer the maximum in compactness, rigidity and adaptability. Through the use of standard NEMA face mounted motors, complete interchangeability between motors is provided. Motor maintenance is possible without disturbing the drive and reducer. Motor assembly is fast and positive with no alignment problems.



Write for your free copy of our new 28 page catalog containing illustrations, charts and tables to help you choose the right Reducer for your particular application. Ask for Bulletin No. M-140.

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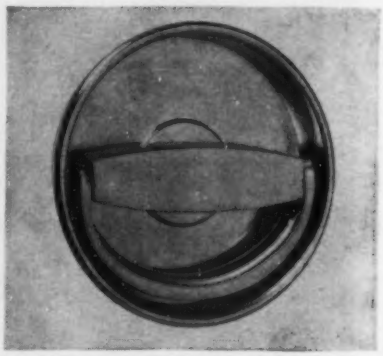
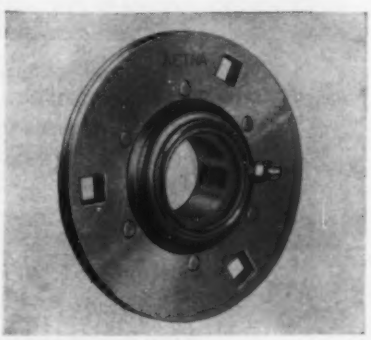
AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY, HARVEY, ILLINOIS

heat generation. Entire line's needle roller diameters are standardized at 0.078 in. Many combinations of bore and OD sizes are available. **Kaydon Engineering Corp, Muskegon, Mich.** See Booth 137 or
Circle 321 on Reader Service Card



Cup and drop handle . . .

in either bronze or aluminum, comes with variety of cams for 1-, 2- or 3-point locking mechanisms. Cup is wrought, while handle and drop ring are cast. Steel spindle for bronze handle is bronze plated; spindle for aluminum handle is cadmium plated. **Corbin Cabinet Lock Div, American Hardware Corp, New Britain, Conn.**
See Booths 1223 and 1225 or
Circle 322 on Reader Service Card



Prelubricated bearing . . .

in factory-assembled package, is suitable for equipment where shafts are supported by sheetmetal members. Has all-in-one flange and outer race, with one-piece rubbing rubber seal protected by a shield. Prepacked with grease, it can be regreased for heavy-duty applications. Available with locking collars to fit standard shaft sizes of ½ through 1¼ in. **Aetna Ball & Roller Bearing Co, 4612 Schubert Ave, Chicago 39.** See Booth 213 or
Circle 323 on Reader Service Card

continued on page 166

ANNOUNCEMENT

CONCERNING

SHALLOW & DEEP ROLLING

DIAPHRAGMS

1. NO MORE TOOLING CHARGES

Over 7,560 different varieties and sizes of Bellofram diaphragms are currently available . . . we will handle all your requirements.

2. 24 HOUR DELIVERY

Over 24,000 diaphragms in stock for fast delivery.

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Area ranges: .08 in.^{2} to 115 in.^{2}
Stroke: .001″ to 14″
Bore: .37″ to 12″

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Temperature range: −120° F to +650° F.
Pressure range: 1″ H_2O to +500 p.s.i. normal
(1,200 p.s.i. limited stroke)

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- New "Standard Diaphragm Sizes" list.
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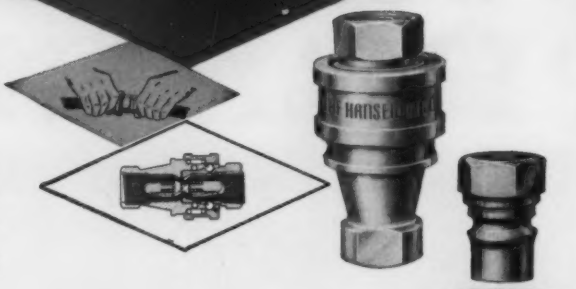
CIRCLE 165 ON READER SERVICE CARD 165

HANSEN

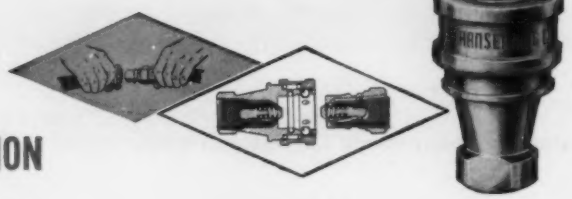
SERIES HK® QUICK-CONNECTIVE

TWO-WAY SHUT-OFF COUPLINGS



QUICK CONNECTION

with instant automatic flow



QUICK DISCONNECTION

with instant automatic shut-off

...prevents loss of liquid, gas, or pressure

As easy as plugging in your electric shaver...

Write for the Hansen Catalog

Here is an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for LP-Gas, Steam, Oxygen, Acetylene, etc.

To connect a Hansen Two-Way Shut-Off Coupling, you merely pull back the sleeve and push the Plug into the Socket. To disconnect, just pull back the sleeve. No tools required. When Coupling is disconnected, similar valves in Socket and Plug shut off both ends of fluid line circuit—practically eliminating spilling of fluid at instant of disconnection.

Available in brass or steel, with female pipe thread connections from ⅛" to 1½" inclusive. Sizes through 1" are also available in stainless steel.

Representatives in Principal Cities ...see Yellow Pages

Booth 512 Design Engineering Show Detroit, May 22-25

SINCE 1915 — QUICK-CONNECTIVE FLUID LINE COUPLINGS

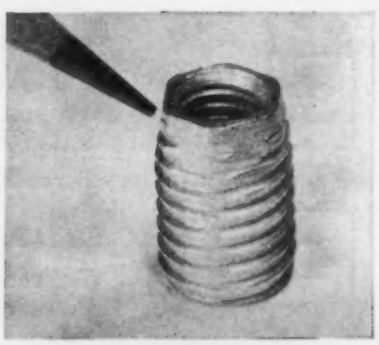
THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO

Rod packing . . .

consists of a D-ring, which provides positive sealing, and double wedge-shape back-up rings which contribute added sealing and guard D-ring from rolling, twisting or extruding. Pressure produces a double cam action in the wedges, extending them fully against rod and gland OD and closing rod clearance so that extrusion is prevented at both rod and D-ring heel. Lip on rear wedge eliminates need for separate wiper element. Entire assembly fits into simple counterbore in cylinder head and is held by a snap ring near cylinder head's outside surface. Unit is said to reduce machining costs sharply because a conventional packing gland or groove has been eliminated. Operates with any fluid and at temperatures from −70 to 600 F. D-ring element is furnished in wide range of rubber compounds, and wedge rings are made of nylon (other plastics or metals on request). Accommodates rod sizes from ½ to 3 in. Greene, Tweed & Co, North Wales, Penna. See Booth 105 or

Circle 324 on Reader Service Card



Self-tapping insert . . .

forms threads without chips. Angles on insert's narrow, threaded lands cause metal to flow around insert as it is driven in. Can be inserted in any soft metal with same tools used to install standard inserts, but is said to offer higher backout torque with no increase in installation torque. Made of case-hardened and cadmium-plated steel and available in sizes No 4 through ⅜ in. dia. Groov-Pin Corp, 1125 Hendricks Causeway, Ridgefield, NJ. See Booth 1221 or

Circle 325 on Reader Service Card

Straight and reverse tapered tubing . . .

is cold-worked to close tolerances from more than 120 standard and special analyses, including carbon and alloy steels, stainless steels, nickel and nickel alloys,

continued on page 171

LEXAN® RESIN MAKES NEW AIR DIFFUSER DESIGN POSSIBLE

A new concept in air distribution—pioneered by Carnes Corporation of Verona, Wisc.—made a reality by LEXAN polycarbonate resin!

In Carnes' design, 6-by-6-inch air diffusers, like those above, form modular units which can be arranged in any desired ceiling pattern. Three different module designs provide complete flexibility in directing air.

"LEXAN resin is the only material we have approved for our diffusers," says Gordon Sylvester, Chief Product Engineer of Carnes. "We tried polystyrenes, polyethylene, nylon and others, but they all fell short in one way or another."

The material for Carnes' diffusers had to meet this combination of requirements: • INJECTION MOLDING for low production cost. LEXAN resin, as a thermoplastic, gave this advantage. • NO HEAT DISTORTION in 225°F. test for handling warm air. In month-long tests of parts, LEXAN resin met this spec. Actually, the resin's rated distortion point is 270-280°F. under load. • DIMENSIONAL STABILITY in use. LEXAN resin was stable. • FLAME RETARDANCE to pass ASTM test. LEXAN resin passed. • COLOR STABILITY and versatility. Although the modules are now a stable white, LEXAN resin offers the possibility of a wide range of colors. • HIGH IMPACT RESISTANCE. Frank Freese, Product and Merchandising Manager for Carnes, really sells LEXAN resin's enormous impact strength. He says "In demonstrating the strength of the modules, we slam them against the wall. It doesn't damage them at all. Metal diffusers would be bent by this treatment."

LEXAN resin has raised the quality of many designs to new levels. It's been substantially reduced in price as new G-E plant facilities have come onstream. Can this tough new thermoplastic help you? Send for design literature. Address General Electric Company, Chemical Materials Dept., Section PE-51, Pittsfield, Mass.

LEXAN®
Polycarbonate Resin
GENERAL ELECTRIC

CIRCLE 167 ON READER SERVICE CARD

THERE'S MUSCLE IN AETNA ROLLER BEARINGS Aetna roller bearings offer an increased load capacity of more than 25%* over conventional roller bearings. This extra muscle is created by Aetna's exclusive True Crowned roller design. In this design, ordinary high stress points are eliminated, and the load is distributed across the full length of the roller for greater efficiency. True Crowning is an example of our advanced technology, which consistently provides you with more dependable bearing performance. Aetna roller bearings are available in a wide range of self-contained, pure radial, standard designs, and in many specials of both pure radial and pure thrust design. For details call your Aetna representative listed in your classified directory, or write for General Catalog and Engineering Manual.

*Determined by AFBMA formula

AETNA BALL AND ROLLER BEARING COMPANY
DIVISION OF PARKERSBURG-AETNA CORPORATION

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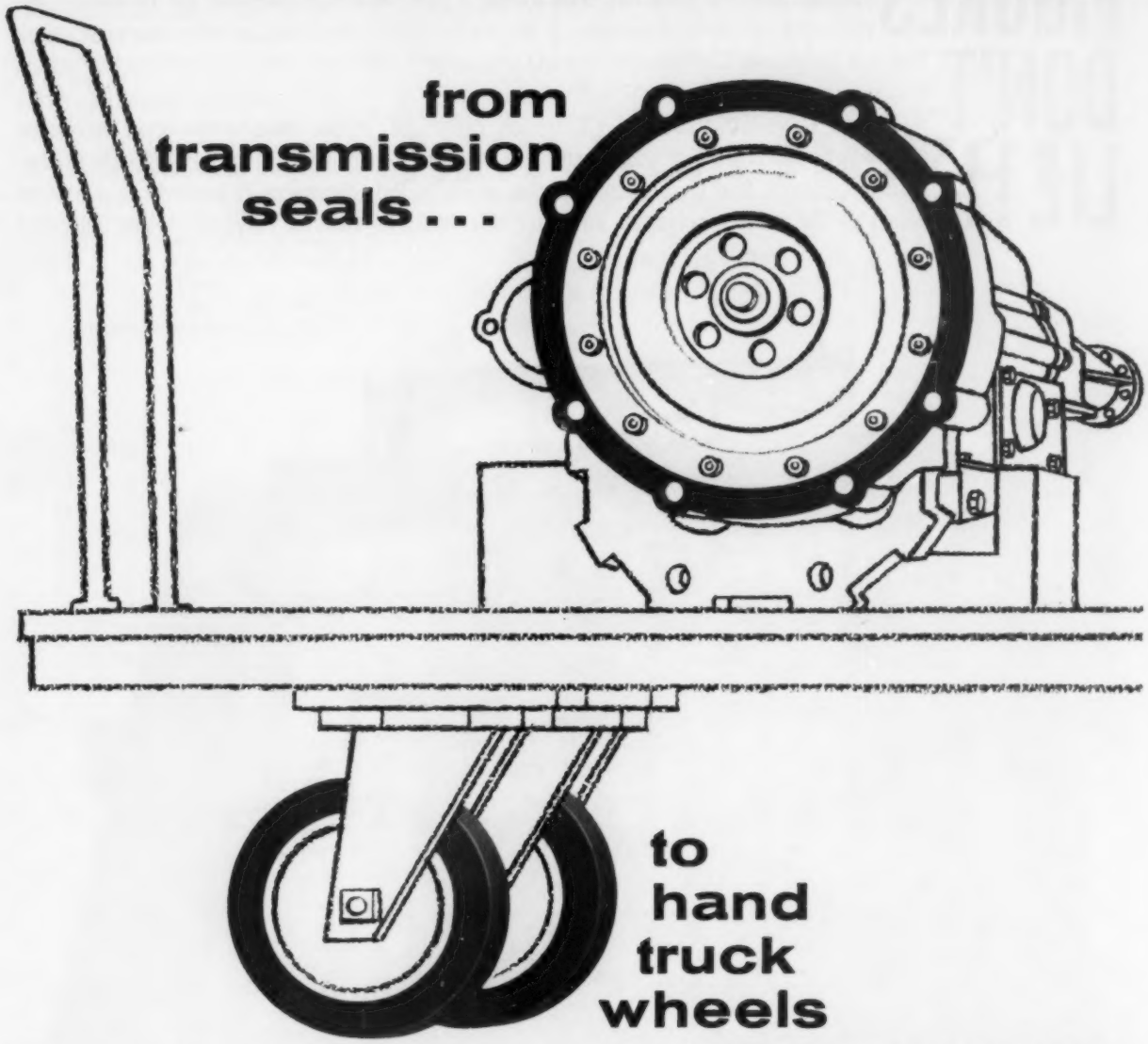
ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

Your Firestone Technical Service Man shapes rubber compounds for everything . . .



Mulling over a design problem that calls for more than ordinary rubber? Your Firestone Technical Service Man compounds rubber for precision seals that stand up to oils and other solvents—for load-bearing industrial wheels that can't crack in cold weather—and for thousands of other special purposes. And he can engineer the rubber compound to fill *your* bill, whether it's for specific abrasion, corrosion, high or low temperature resistance or for a combination of requirements. Your Technical Service Man also creates rubber compounds that replace costlier materials. And Firestone's high-volume, high-accuracy production facilities are at your service, too, to carry the job right through to its final stage within strict cost limits. Details? Just fill out and mail the coupon—without obligation, of course.

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Firestone
Rubber & Latex Products Company
Fall River, Massachusetts

WITHOUT OBLIGATION, WE'D LIKE TO FIND OUT WHAT FIRESTONE'S TECHNICAL SERVICE MAN HAS TO OFFER US. FMR-FR15 (1)

Name and Title

Company

Product Manufactured

Address

City

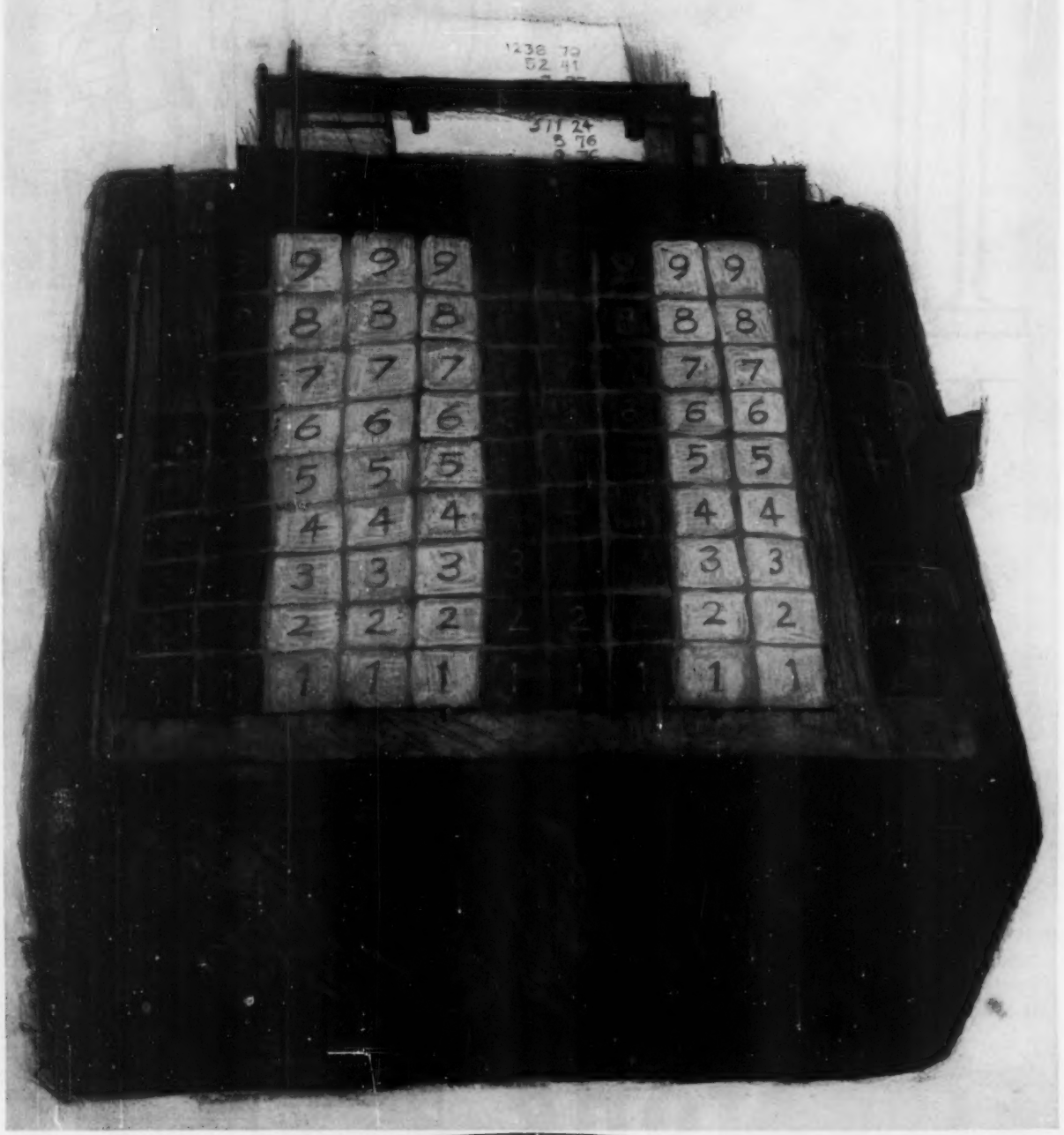
State

FIRESTONE
RUBBER & LATEX
PRODUCTS CO.
Box 2290, Fall River, Mass.

CIRCLE 169 ON READER SERVICE CARD 169

FIGURES DON'T LIE!!

You save when you solve materials problems with Laminac® Laminac polyester resin has been solving difficult materials problems for 19 years—and delivering substantial economies in the process. Reinforced Laminac offers you economical, high and low-volume fabrication of unusual shapes, large and small. Plus: Low-cost tooling • High structural and impact strength • Dimensional stability • Superior electrical properties • Arc resistance • Dielectric strength • Corrosion resistance. In one molding operation, reinforced Laminac gives form, strength, color and finish to business machine housings, furniture, photo processing equipment, food trays, countless other products. Put your materials problems to reinforced Laminac—the pioneer polyester. Write for free booklet, "Laminac Polyester Resins Selector."

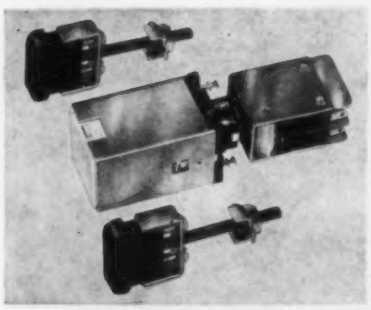


AMERICAN CYANAMID COMPANY CYANAMID **PLASTICS AND RESINS DIVISION**

WALLINGFORD, CONNECTICUT. *OFFICES IN:* BOSTON • CHARLOTTE • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DETROIT • LOS ANGELES MINNEAPOLIS • NEW YORK • OAKLAND • PHILADELPHIA • ST. LOUIS • SEATTLE • *IN CANADA:* CYANAMID OF CANADA LIMITED, MONTREAL • TORONTO

beryllium copper and reactive metals such as titanium and Zircaloy. OD's range from 0.080 to 1.5 in.; wall thicknesses from 0.012 to 0.0625 in.; and lengths, up to 10 ft. Reverse tapered tubing is available in two forms: tapered from middle to both ends and tapered from ends to middle. Straight tapered tubing is tapered continuosly from one end to other. Made to same commercial OD, ID and wall tolerances of non-tapered tubing in same size range. **Superior Tube Co, Germantown Ave, Norristown, Penna.**

See Booth 849 or
Circle 326 on Reader Service Card



Lighted pushbutton switch . . . combines panel-light indicator with pair of 2-pole subminiature switches measuring $\frac{7}{8}$x$\frac{7}{8}$x3 in. long. Up to four miniature lamps project through colored filters to indicator screen. Each switch can control two 5-amp, 30-v dc circuits or two 10-amp, 125/250-v ac circuits. Bulbs are accessible without special tools. Mechanical life exceeds 20 million cycles. Installed by barrier mounting system or with conventional flanges. **Licon Div, Illinois Tool Works, 6615 W. Irving Park Rd, Chicago 39.**

See Booth 844 or
Circle 327 on Reader Service Card

Hydraulic filters . . . for use on suction lines, are rated for flows from 2 to 250 gpm. Have mechanical pointers, indicating when cartridges should be replaced, or are available with electrical actuation for indication by signal light or bell. Electrical signal also can be used to stop pump automatically. **Vickers Inc, Div of Sperry Rand Corp, Detroit 32.**

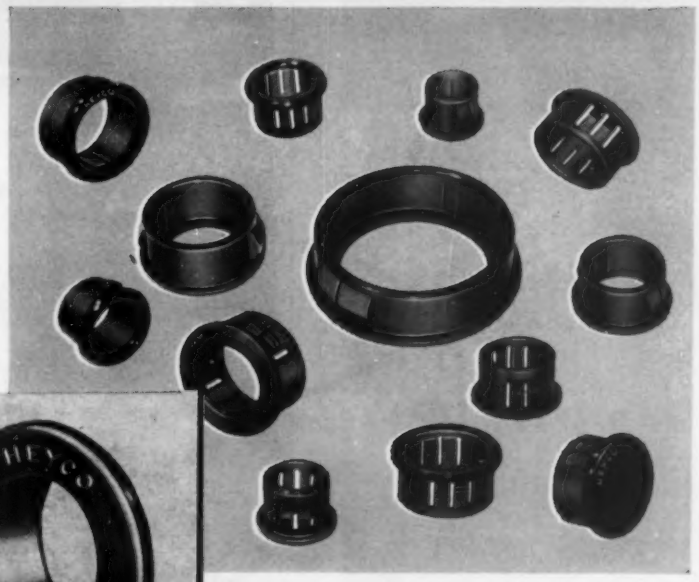
See Booth 549 or
Circle 328 on Reader Service Card

Dry-film lubricant . . . is resin-bonded and packaged in aerosol. Surface to be lubricated need only be degreased before spray. Lubricant will with-

continued on page 173

NYLON Snap Bushings

NEW From HEYCO.



Snaps easily and locks into panels of varying thickness up to ⅛"
withstands 35 lb. pushback test!

Here's a Bushing to meet your requirements

- Finger pressure assembly
- Provides complete insulation–it's Nylon
- Approved for temperatures of 302°F.
- Not affected by oil or grease
- Sizes for 1/4" to 2" mounting holes
- Various inside diameters

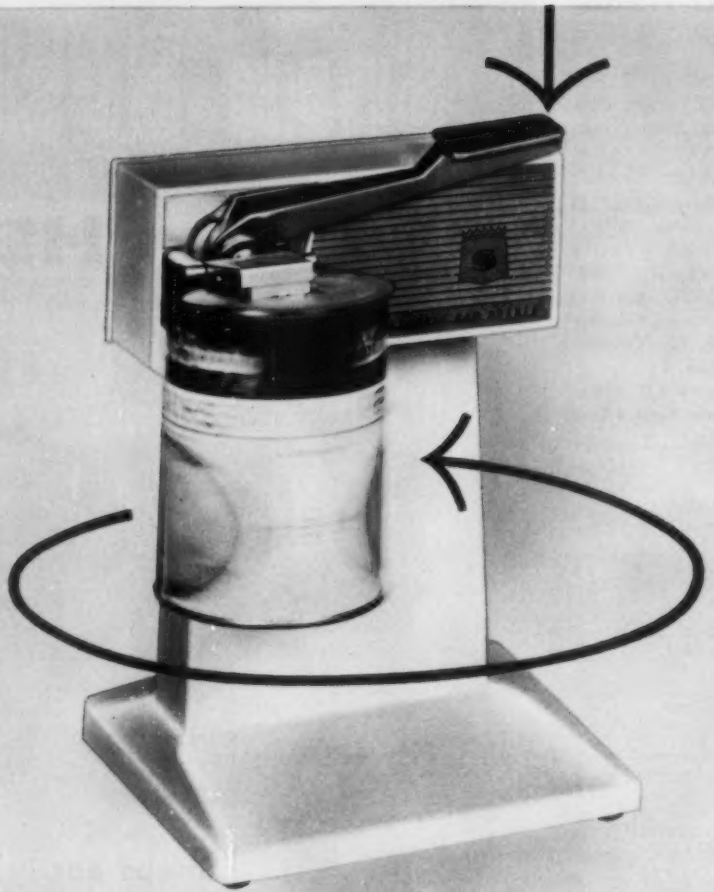
AVAILABLE AS HOLE PLUGS NOT UL or CSA LISTED

USES:
Insulation and mechanical protection for Electrical Wire & Cable, Tubing & Hose, Rope & Cable, Bearing Surface for Moving Parts.

Samples are FREE

HEYCO®

HEYMAN MANUFACTURING CO.
KENILWORTH 3, NEW JERSEY



Silent nylon gears drive new Sunbeam electric can opener

Manufacturers are often able to gain more than cost savings through the use of custom-molded plastic components. A good example is this new Sunbeam electric can opener. To obtain quiet, maintenance-free operation, custom molded nylon gears were used instead of metal. For appearance, strength and ease of cleaning, Tyril®, a rigid thermoplastic, was used for the housing and base.

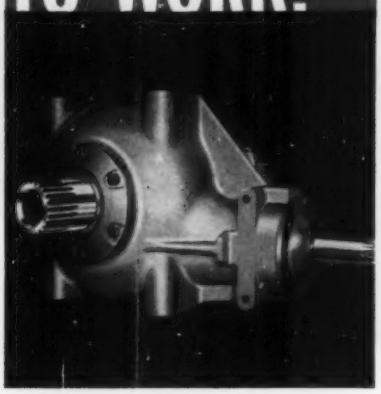
Chicago Molded sales engineers worked closely with Sunbeam designers in the selection of Nylatron® GS nylon for the gear train because of its sound-deadening, wear-resistant and self-lubricating qualities. Tyril was selected because of its resistance to acids, soaps, and food stains. Through the combined engineering skills of both Sunbeam Corporation and Chicago Molded Products, it was possible to design and produce more efficient, less costly components that resulted in a superior, better selling end-product.

Send for new brochure "Design and Purchase of Custom Molded Plastics."

CMPC

CHICAGO MOLDED PRODUCTS CORPORATION
1020 D North Kolmar Avenue
Chicago 51, Illinois

TO PUT YOUR MECHANICAL POWER TRANS-MISSION IDEAS TO WORK:



Let Warner Automotive's staff develop a special gear box for your needs, as was done for the CASE 200 Hay Baler . . . a rugged, dependable, yet lighterweight gear box with housing of malleable iron, hypoid gears carburized for long life, integral ring gear carrier and splined crankshaft, tapered root spline on input shaft, anti-friction bearings throughout. Consult Warner on any mechanical power transmission problem—without obligation.

WARNER B-W

AUTOMOTIVE DIVISION

BORG-WARNER CORPORATION
AUBURN, INDIANA

For Hydraulic Power Transmission, See Wooster Division

stand high pressures and temperatures from —100 to 500 F. Will not collect dust or dirt, or wash or rub away. In two formulas. One with epoxy resin adhesive must be baked, is chemically insoluble when cured; 5400 sq in. covered by $4.25 can. Another with lacquer resin adhesive must be air-dried 3 to 6 hr, is chemically resistant; 3000 sq in. covered by $3.75 can. **Poxylube Inc (formerly Poly Chem), 541 S Webster Ave, Indianapolis 19.**

See Booth 1138 or
Circle 329 on Reader Service Card

Integral pump and motor . . .

will pump 12 cfm and produce vacuums to 27 in. Hg or 15-psig pressures. Motor is ½ hp, either 110-220 v ac single phase or 220-440 v ac 3 phase. Standard accessories include inlet air filter, automatic lubricator, and outlet oil vapor-silencer. Measures 22½x12x9½ in. Priced from $99 to $210; delivery in 2 wk. **Leiman Bros Inc, PO Box 1339, Newark 1, NJ.**

See Booth 129 or
Circle 330 on Reader Service Card

Cap screw . . .

is externally wrenched in standard counterbored holes with standard socket wrenches. Body diameters are No 10 and ¼ to 1 in. Tensile strength of No 10 (0.190 in.) to ¾-in.-dia screws is 170,000 psi; ⅞ to 1 in. dia, 150,000 psi. **Ferry Cap & Set Screw Co, 2151 Scranton Rd, Cleveland 13.**

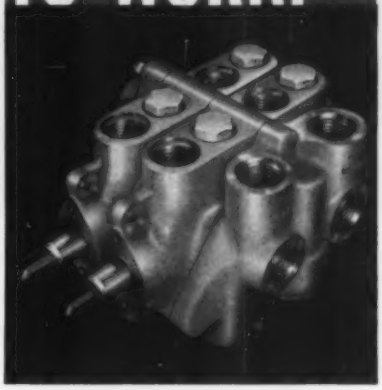
See Booth 809 or
Circle 331 on Reader Service Card

Circuit package . . .

produces bounce-free voltage output from a mechanical switch, eliminating spurious voltage pulses caused by contact bounce in pulse and digital systems. Suitable for high-speed electronic components that operate in less than a microsec. Four packages available. One produces positive

continued on page 175

TO PUT YOUR HYDRAULIC POWER TRANS-MISSION IDEAS TO WORK:

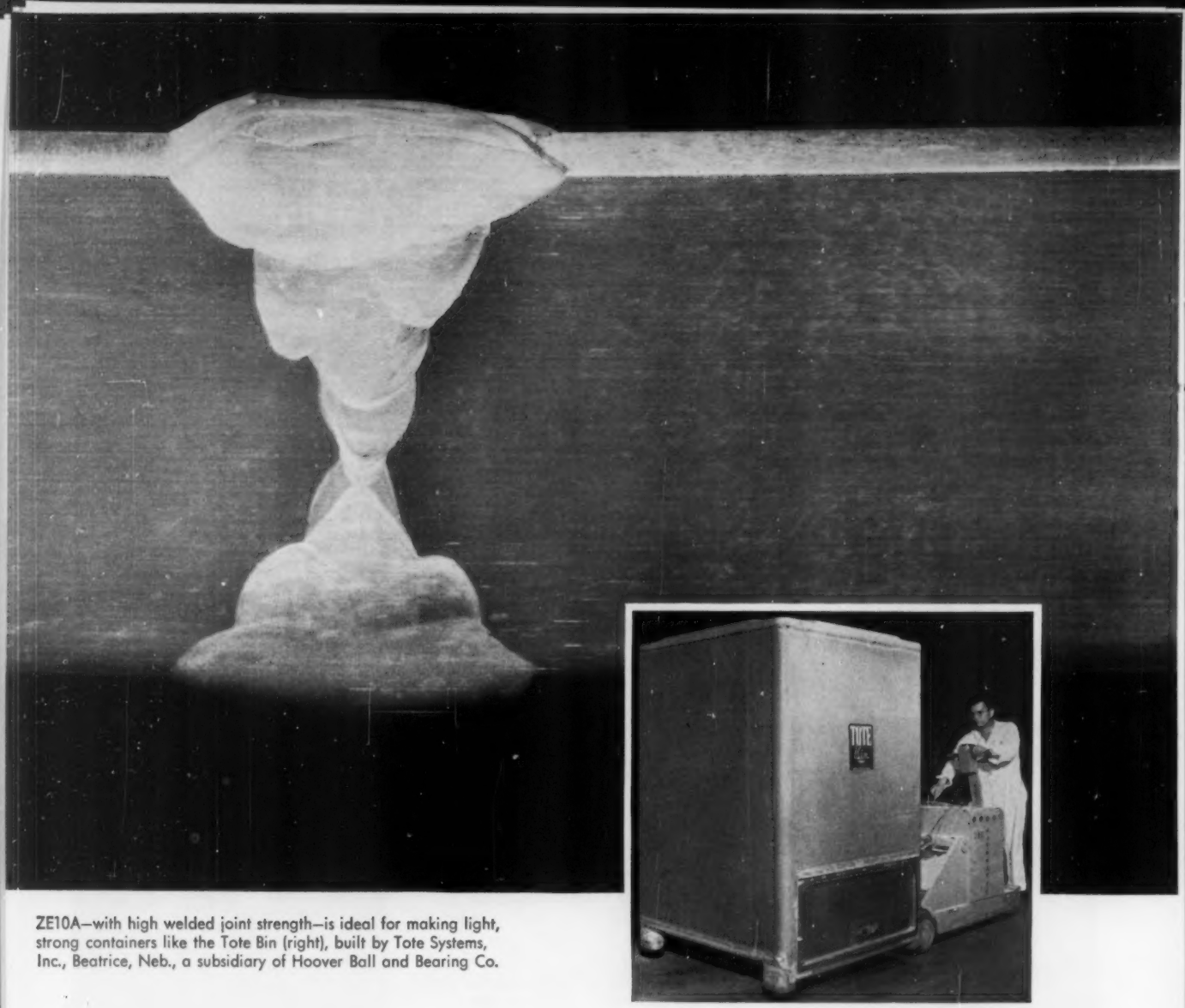


Use the unique precision of Wooster's 2D Directional Control Valve . . . parallel circuit, open center, stack type with simple 3-bolt mounting . . . to control the lifting, tilting, positioning of agricultural implements, materials handling, mobile equipment and industrial applications. Operating pressures to 2000 PSI with extremely low losses. Built-in switch valve to change from 4- to 3-way operation in the field. Produced on building block principle, materially lowering cost without sacrifice of quality.

WOOSTER DIVISION B-W

BORG-WARNER CORPORATION
WOOSTER, OHIO

For Mechanical Power Transmission, See Warner Automotive Division



ZE10A—with high welded joint strength—is ideal for making light, strong containers like the Tote Bin (right), built by Tote Systems, Inc., Beatrice, Neb., a subsidiary of Hoover Ball and Bearing Co.

NEW DOW MAGNESIUM ALLOY ZE10A . . .

high welded joint strength and no stress relief!

New Dow magnesium alloy ZE10A needs no post-welding stress relief. This strong sheet alloy is tailor-made for fabricating containers, truck bodies and other large structures. And it's ideal for field repair operations where stress relief can be a real problem.

ZE10A also offers the advantage of very high welded joint strength, a matter of importance in butt welding. The result is strong, stiff, welded containers which are extremely light in weight . . . with greater capacity, pound-for-pound, than containers made from any other metal! And ZE10A provides maximum dent resistance.

When welding ZE10A magnesium sheet to extrusions, use Dow magnesium extrusion alloy ZK21A. *Neither* alloy requires stress relief after welding. For further information and data on Dow magnesium alloys, write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1112DZ5-15.

DOW

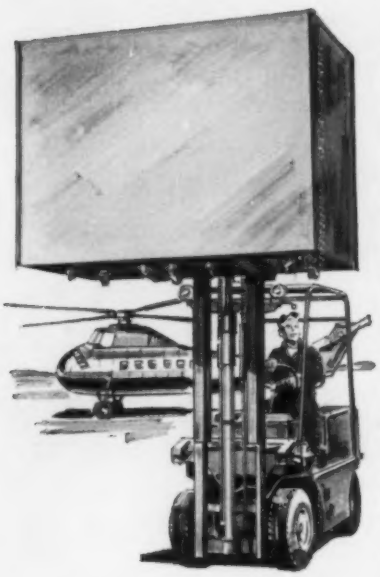
THE DOW METAL PRODUCTS COMPANY

Division of The Dow Chemical Company

CIRCLE 174 ON READER SERVICE CARD

DOW

HOW MAGNESIUM NO-RIB DESIGN CUTS CONTAINER COSTS AND WEIGHT



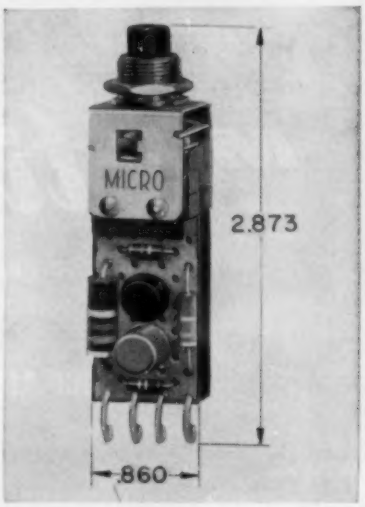
Cargo containers can be made both strong and light . . . and at less cost . . . with magnesium no-rib design. Fabricated from stiff sheets of lightweight magnesium, container walls need no stiffening ribs or supports.

No-rib design eliminates costly, time-consuming installation of ribs and fasteners . . . provides strong, dent-resistant walls that are smooth inside and out . . . produces economical containers that, pound-for-pound, have greater cubic capacity than ribbed containers of any other metal.

Dow magnesium sheet alloy ZE10A is ideal for no-rib construction. It provides high welded-joint strength and *needs no stress relief* after welding. For equipment handling and cargo containers, storage bins, vehicle bodies, magnesium no-rib construction offers maximum strength at lightest weight . . . and savings in construction time and costs!

DOW

THE DOW METAL PRODUCTS COMPANY
Division of The Dow Chemical Company
Midland, Michigan



output for resistive loads of 100 to 500 ohm; another produces positive output for 500-ohm or greater resistive loads; and two produce negative output voltage for these loads. Can be furnished assembled to variety of pushbutton and toggle switches or separately. From stock at $12 to $14. **Micro Switch Div, Minneapolis-Honeywell Regulator Co, Freeport, Ill.**

See Booth 1211 or
Circle 332 on Reader Service Card

Selective-speed drives . . .

with aircooled magnetic couplings, have magnetic amplifier regulators with tachometer feedback control to regulate within 2% of max speed. Available as constant-torque units from 5 to 150 hp and variable-torque units from 11.2 to 300 hp for operation from polyphase line. Silicone-controlled rectifier drive has 15 speeds in a 75:1 range with constant-torque output and speed regulation ±2% max speed. Available 1/12 to 7½ hp from 115-v single phase line. Mechanical selective-speed drives are in four sizes from ½ to 30 hp with up to 8:1 speed ratios. Have double sealed bearings, chrome-plated shafts and keys and fan-cooled drive belt. Helical gear reducers may be mounted integrally for low speed ratios, with foot or flange mountings. Can be equipped with pneumatic or electric remote control. **Century Electric Co, 18th & Pine Sts, St Louis 3.**

See Booth 921 or
Circle 333 on Reader Service Card

Hydraulic-magnetic circuit breaker . . .

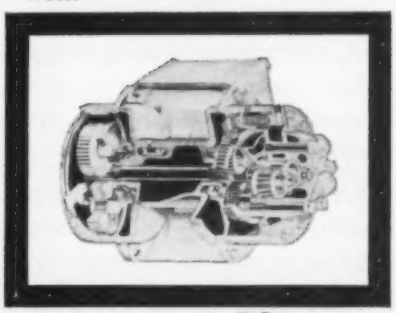
measuring little more than size of a matchbox and weighing 1½ oz, is said to be first

continued on page 177

GEARMATIC
HYDRAULIC WINCHDRUMS

- **Fully-hydraulic proven design**
- **Line pull capacities 6000-22,000 lbs.**
- **Simple, single-valve control**
- **Automatic pressure-actuated brake**

Gearmatic's sensational new hydraulic winchdrums . . . models 6, 11 and 22 . . . reverse at 0 to 5.25 times forward speed, unloaded or under load. Automatic reversing is also available. Write for Bulletin H-860.



gearmatic
COMPANY LTD.
7400-132 Street, North Surrey, B.C., Canada
GHCD-61

*Trademark of Metals & Controls Inc.

. . . we'll put them together for you

When you are choosing materials for new designs, or when conducting value analysis on existing products, don't compromise on the qualities the parts must have. If you are now using single metals or alloys, chances are you're compromising.

For example, if you need thermal and electrical conductivity, and springiness, no one metal can give you the optimum in all three requirements.

That's where MULtiLAYER fits into the picture. We will give you a spring steel base material with a layer of copper clad to it and will weld and coin a gold contact ball onto the blade for electrical conductivity. Besides giving you more beneficial engineering properties, MULtiLAYER will probably save you money because you will need less precious metal.

MULtiLAYER, with its hundreds of possible combinations, gives you another modern material. Take advantage of it. WRITE for our general catalog, GP-1B, which describes this material in more detail and illustrates many thought-provoking applications.

See this Modern Design Material in Booth 1201 Design Engineering Show Cobo Hall, Detroit, Michigan, May 22-25, 1961

METALS & CONTROLS INC.
1000 FOREST STREET • ATTLEBORO, MASS
A CORPORATE DIVISION OF
TEXAS INSTRUMENTS
INCORPORATED

MULtiLAYER*
clad metals combine all 4
• Thermal Conductivity
• Corrosion Resistance
• Strength
• Flexibility
in ONE strip

*Trademark of Metals & Controls Inc.

MULtiLAYER provided *all* these metal qualities for heat exchanger fins used in supersonic aircraft and missiles. Designed with a copper core for greater thermal conductivity, the fins thus increased the efficiency of the exchanger. Soft tempered stainless steel cladding was selected for its anti-corrosion properties, and for its conformability when wound around the exchanger in a spiral. It was also wetable by Coast Metal #53 brazing alloy to insure a continuous, high-strength connection. If the metal qualities required of your product are equally or more diverse, MULtiLAYER can solve *your* problem as well. Write for FREE LITERATURE describing physical and mechanical characteristics of this strip, and other specifications such as coefficients of expansion, forms and sizes, and weights.

METALS & CONTROLS INC.,
1005 Forest Street, Attleboro, Mass.

A CORPORATE DIVISION OF
TEXAS INSTRUMENTS INCORPORATED

breaker of its type to be priced for commercial applications. Requires only single mounting hole and doubles as "on-off" power switch. Operates at 110 v, 60 or 400 c ac, or at 50 v dc in any current rating from 0.05 through 15 amp. Fully magnetic actuation makes derating unnecessary, and because unit has no thermal elements, it carries full-rated current and maintains must-trip point under high or low ambient temperatures. Can be supplied with either fast or slow inverse time-delay or with instantaneous (no-time-delay) response. On short circuits or high overloads, time-delay models trip instantaneously. Also available in shunt-trip, relay-trip and calibrating-tap models. Shunt- and relay-trip circuits allow breaker to be tripped electrically from remote source. Calibrating circuit permits two loads to be controlled with one single-pole breaker. **Heinemann Electric Co, 378 Magnetic Dr, Trenton 2, NJ.** See Booth 1247 or
Circle 334 on Reader Service Card

Direct-operated solenoid valve

with pressure range from 0 to 130 psi is designed primarily for radioactive corrosive service. Available in all voltages and from ¼ to 1-in. line sizes. Now being used in isotope processing. Delivery in 3 to 4 wk. **Valcor Engineering Corp, 365 Carnegie Ave, Kenilworth, NJ.**
See Booths 1243 and 1245 or
Circle 335 on Reader Service Card

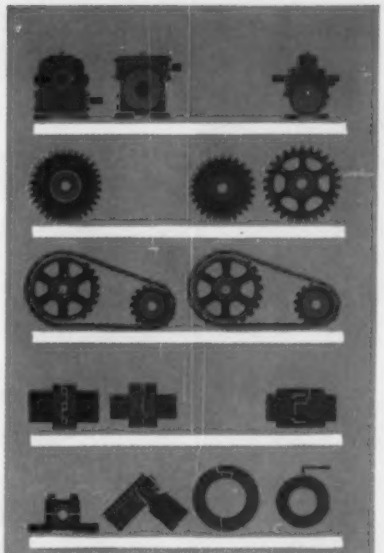
Rigid urethane foam . . .

is self-extinguishing and available in densities of 2 and 6 lb per cu ft. Intermediate densities can be supplied on request. **Toyad Corp, Plant Blvd, Latrobe, Penna.**
See Booth 344 or
Circle 336 on Reader Service Card

Quick-connect for permanent piping . . .

needs no flexible hose at either end and seals tight on rubber gasket. Suitable in pairs for quick addition or removal of relief, flow-control or check valves, gages, pumps or meters in permanent pneumatic, hydraulic or other fluid-flow lines. Since flow through coupling is through easily cleaned straight pipe, perishable fluids can be handled. Available in ¼ and 1-in. ID sizes in cadmium-plated steel, anodized aluminum or Type 316 stainless steel, passivated. End fitting choices for 1-in. size include: ¾ and 1-in. male and female pipe threads; and ¾-, $\frac{13}{16}$-, ⅞-, $\frac{13}{16}$-, 1-, 1⅛-, $1\frac{5}{16}$- and 1¼-in. tube for brazing or welding.

continued on page 179



INSTANT
SOURCE

Charles Bond's large factory and distributor stocks provide an ideal "instant source" for Power Transmission Equipment for today's replacement and design applications. Frequently, the use of a Bond stock component eliminates the need to create a new component—with attendant delay and expense. When required Bond does create special units to your specifications.

Remember Bond—a leader in the power transmission field for three quarters of a century.

AGMA MEMBER

SEE YOUR NEAREST BOND DISTRIBUTOR

or check with Charles Bond Co. for: speed reducers—gears—flexible couplings — sprockets and chains—universal joints—collars —pillow blocks.

Write for Catalog No. 100

CHARLES BOND COMPANY

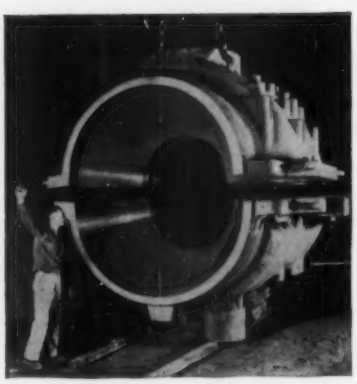
617-23 Arch Street, Phila. 6, Pa.

Design assistance from Blaw-Knox can cut unnecessary weight, improve the service life of your product

One of the ways in which the skill of experienced Blaw-Knox steel foundrymen can be first applied to your product is in the construction of scale models of the finished steel casting. Coming at the preliminary design stage, scale models permit intensive study of ways of improving quality, eliminating weight, and minimizing machining. This design study, coming before master patterns are made, is conducted to uncover ways in which Blaw-Knox can add to the value of your product or reduce its cost.

This practical design analysis, a feature of Blaw-Knox Steel Casting Service, is of invaluable assistance to designers and manufacturers. And because Blaw-Knox, itself, is one of the world's leading manufacturers of rolling mills and industrial machines, its steel foundrymen, from patternmaker to shipper, keep end-use requirements in mind every step of the way.

If you are a designer or manufacturer of a product using cast steel components, ranging from 50 pounds to 300,000 pounds, Blaw-Knox would like to send you a copy of our brochure which details the complete Blaw-Knox Steel Casting Service. Write to the Foundry and Mill Machinery Division, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.



This upper and lower cylinder blade ring for a steam turbine was cast and machined by Blaw-Knox. Weight—55,000 pounds per half.

BLAW-KNOX

Steel Castings

End fitting choices for ½-in. size are: ½-in. male pipe thread; ¾ and ¼-in. male and female pipe threads; or $\frac{11}{16}$-, $\frac{5}{8}$-, ½-, $\frac{7}{16}$-, ⅜- and $\frac{5}{16}$-in. tube for brazing or welding. Prices of ½-in. size are from $7.60 in aluminum to $31 in stainless steel; 1-in. size ranges from $12 in aluminum to $79 in stainless steel. Delivery in 4 wk. **Snap-Tite Inc, Union City, Penna.**

See Booth 1029 or

Circle 337 on Reader Service Card

Miniaturized power relay . . . is DPST unit, conservatively rated 20 amps per pole at 115 v ac. Available with normally open and/or normally closed mercury-to- mercury contacts within an inert arc-quenching atmosphere. Measures 3½x4x1$\frac{7}{8}$ in. and is suitable for control of electric heater and furnace loads, lighting, motor starting and general purpose use. All terminals are up front and easily accessible. From stock at $12.45 to $18.75, depending upon quantity. **Ebert Electronics Corp, 212-26 Jamaica Ave, Queens Village 28, NY.**

See Booth 1119 or

Circle 338 on Reader Service Card

Three-winged socket . . . is installed or removed for adjustment with driver bit, resisting attempts at tampering or removal by unauthorized personnel. Available in all sizes, types and materials generally specified for threaded fasteners. **American Screw Co, Willimantic, Conn.**

See Booth 835 or

Circle 339 on Reader Service Card

Mercury-wetted relays . . . consist of up to four single mercury-wetted contact capsules enclosed in steel vacuum tube-type housing. Have speeds up to 100

continued on page 184

PROVED IN SERVICE . . . for 20 YEARS

APEX
COVERED
UNIVERSAL
JOINTS

pre-lubricated and sealed

Since 1941, Apex *covered* universal joints have operated efficiently in liquids and gases . . . in corrosive and abrasive atmospheres . . . under pressures . . . and in extremes of temperatures.

The flexible covers that make this possible are produced from a variety of materials, each selected to meet specific operating and environmental conditions. Two swaged rings secure the cover to the joint to provide a positive, oiltight seal that assures clean, sustained lubrication and protects the joint itself. Covers are designed to allow ample joint clearance, even at extreme operating angles.

Apex *covered* universal joints are available in 13 stock sizes, ⅜" to 4" diameter, all of them built for heavy-duty service.

SEE OUR CATALOG IN SWEET'S

or write, on your company letterhead please, for Catalog 28 and Universal Joint Data Sheets.

THE APEX MACHINE & TOOL CO.
1042 South Patterson Blvd.
DAYTON 2, OHIO

UNIVERSAL JOINTS AND ASSEMBLIES
for Industrial and Military Applications

the big news story for suppliers and users of elasto-plastic components!

TEXIN

Now Permits Mass Production of Urethane Elastomer Parts by Low-Cost Injection and Transfer Molding or Extrusion

TEXIN, a newly-developed urethane elastomer "green stock" resin supplied in chopped particle form, is designed for those mass market industrial applications which require a highly-functional elasto-plastic material that can be simply processed with existing equipment by fast-cycle, low-cost methods.

TEXIN by-passes the costly, time-consuming liquid casting system formerly required in processing cured urethane elastomer items. Yet, it gives you the immediate market advantage of a thoroughly field-tested material, with properties identical to cast Multrathane® elastomers, while reducing part-forming time from hours to a matter of seconds.

TEXIN is specially formulated for heavy-duty applications which demand the unusual combination of wear resistance, hardness, elasticity, and high impact and mechanical strengths — particularly in original equipment components having difficult design features such as undercuts, slots, tapers, gear teeth, inserts and threads subject to high abrasive wear or oil immersion. Literally hundreds of these applications, many not adaptable to casting methods, are 'right' for molded urethane elastomer. TEXIN can bring them in.

The markets for urethane elastomer items are already well developed and waiting to hook into your production line. For full details and technical assistance, write immediately to Mobay Chemical Company, Code PN-18, Pittsburgh 5, Pa.

e-8

Typical minimum physical properties of two grades of TEXIN

Type	Specific Gravity	Bulk Factor	Hardness		Tensile Strength	Elongation at break	Tensile Modulus psi			Elongation Set	Tear Strength
			Shore A	Shore D			100%	200%	300%		
192 A Molding Grade	1.25	2.7	92–94	44–45	4400 psi	600%	1150	1550	2050	45%	300 lbs.
280 A Extrusion Grade	1.25	2.7	80	—	5500 psi	600%	650	900	1500	30%	—

Send for your copy of Texin Topics, an illustrated bulletin describing the latest application developments in the urethane elastomer field.

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JUNE 5-9, 1961 COLISEUM, N.Y.C.
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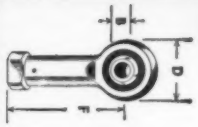
MOBAY

Unibal®

THE ORIGINAL SPHERICAL BEARING ENGINEERED AND DEVELOPED BY HEIM

Unibal spherical bearings consist of a ball, with centralized bore, mounted, and universally movable in an outer member. They greatly simplify design problems requiring high-capacity, self-aligning bearings and rod ends, particularly in mechanical linkages.



ROD ENDS

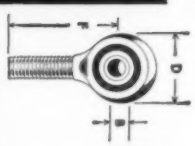
with internal (female) threading

An indication of the range of sizes

F—Length to center of ball .812 to 2.875
D—Outside diameter .469 to 1.750
B—Bore .125 to .750

Female rod ends are for linkages using rod stock.

ROD ENDS with external (male) threading



An indication of the range of sizes

F—Length to center of ball .937 to 2.875
D—Outside diameter .469 to 1.750
B—Bore .125 to .750

Male rod ends are for linkages using tubular stock.

Materials used vary with specific requirements; balls are hardened steel, bearing inserts usually bronze, outer members can be of any suitable material such as carbon steel, aluminum, aircraft steel, etc.

Both male and female rod ends are available with lubricators.

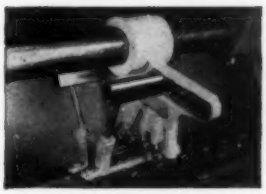
Flush type lubricator

Standard lubricator

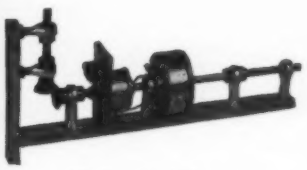
For self-aligning rod end bearings to withstand high loads at low speeds without lubrication, there are Unibal rod ends lined with "teflon".

An unthreaded shank series is also available for attaching by means other than threading. These are made with "B" dimensions from .190 to .250.

Unibal rod ends make excellent and inexpensive shaft supports and hangers.



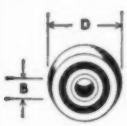
Suspension hangers for guide bars on knitting machine.



Shaft supports for clutch assembly shafts.

SPHERICAL BEARING, or cartridge unit

Designed to correct misalignment in every direction and to operate under high-static loads or reduced loads at low speeds.



An indication of the range of sizes

B—Bore .1250 to 1.8750
D—Outside diameter .4687 to 4.000

Three types of mounting for Unibal, showing angle of misalignment for each.

There are 2-piece Unibal bearings which can be had with conventional materials as well as with sintered iron balls, standard hardened steel balls, sintered iron or sintered bronze outer members, or almost any other suitable material.

Teflon provides long-wearing, low-friction, self-lubricating, high impact, vibration resistant properties when used as lining for Unibal bearings. For applications where speed ratings are not severe and minimum torque is essential.

Complete list of sizes, specifications, and load ratings is shown in Heim catalog and brochures. Please contact your nearest bearings distributor or write direct to manufacturer.

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

CIRCLE 181 ON READER SERVICE CARD 181

Malleable Puts More Muscle in Machinery

In the agricultural equipment field, reputations depend on building products that can take rough treatment . . . and give real value. To do it, agricultural equipment manufacturers rely heavily on Malleable iron castings.

Malleable's excellent ductility and shock resistance mean longer life and fewer problems than obtainable with fabrications. Low start-up cost for small quantities also is vitally important in this competitive industry.

Put more reputation-building quality into your products at less cost with Malleable. For design assistance or quotations, call any company that displays this symbol —

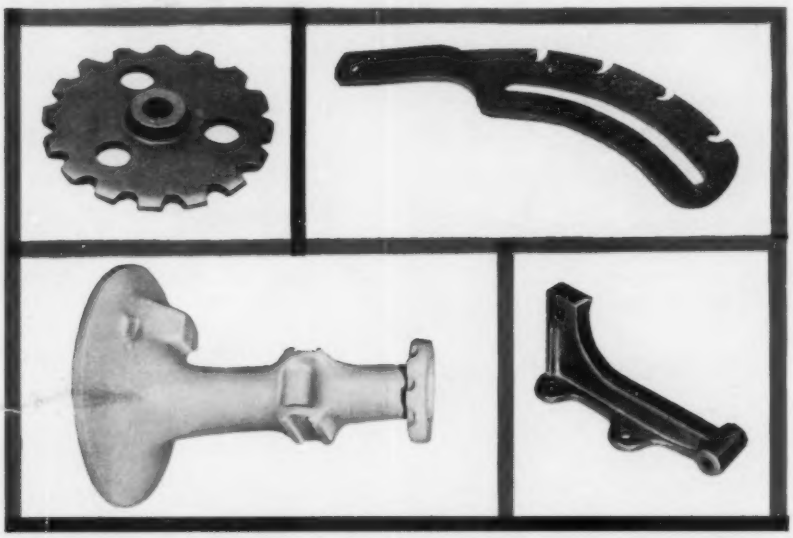
PROBLEM-SOLVING IDEAS are yours free in Data Unit No. 115. For your copy, ask any member of the Malleable Castings Council, or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

MEMBER
MALLEABLE
CASTINGS COUNCIL

The versatility of Malleable castings is reflected in the variety of ferritic and pearlitic Malleable tractor parts, from the tough, dependable front axle bar to bolsters, lift arms, clamps, clevises, hitches, hinges, foot pedals, transmission planetary carriers and clutch parts.

No machining or hardening is required on this Malleable chain sprocket. It replaces a part cut from steel plate to which a hub was welded. Cost was reduced 12%. Tests verified the excellent performance of the malleable part, and led to a review of the company's entire manufacture of chain sprockets.

Field failures stopped as soon as the manufacturer of this plow quadrant began using a Malleable casting in place of a welded fabrication. This part looks better, works better, and quality is uniform in every piece. Yet the Malleable quadrant costs 22% less than the fabrication.



The strength of Malleable is illustrated by farm tractor rear axle housings. They must absorb the constant shock and strain exerted as heavy implements are dragged over rough fields. Toughness, ease of machining and economy make Malleable first choice for this demanding application.

Costs dropped 59% when this disc harrow ram anchor was converted from a weldment to a Malleable casting. Malleable's shock resistance combined with a better design resulted in a part able to withstand constant punishment.

For Quality and Economy Use

MALLEABLE

For Service Contact...

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 8
Eastern Malleable Iron Co., Naugatuck

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Iron Works, Moline
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Albion Malleable Iron Company, Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

These companies are members of the Malleable Castings Council

CIRCLE 183 ON READER SERVICE CARD 183

Draftsmen can perform their entire job in seated comfort only with

GF
Draft-a-Matic

Here's how Draft-a-Matic solved a work-space problem for a large West Coast company. By replacing conventional drafting desks with Draft-a-Matics, overcrowding was completely eliminated—yet, 12% more personnel were comfortably and efficiently accommodated in the same space. With Draft-a-Matic, you get a complete work and reference station in only 32 square feet of valuable floor space.

Let us show you how

DRAFT•A•MATIC

saves space... increases productivity... cuts costs

Visit with us in

BOOTH 942

1961 DESIGN ENGINEERING SHOW

AND CONCURRENT ASME CONFERENCE

MAY 22-25

COBO HALL • DETROIT

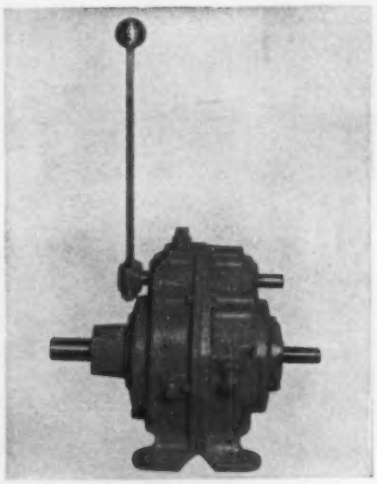
GF
BUSINESS FURNITURE

DEPT. PE-11 • THE GENERAL FIREPROOFING COMPANY • YOUNGSTOWN 1, OHIO

operations per sec and handle loads up to 250 v-amp (500 v, 5 amp max). Also said to offer low contact resistance throughout life; no pitting or dirt; and positive closure. Red epoxy resin-molded relays in single or double contact versions are for printed circuit work. Single contact type measures $\frac{7}{8}$x$\frac{7}{8}$x3 in.; two contact type, $\frac{7}{8}$x1.23x3 in. Terminal pin arrangement is to the 0.2-in. grid; other configurations on request. **Relay Div, Adams & Westlake Co, Elkhart, Ind.**

See Booth 201 or

Circle 340 on Reader Service Card



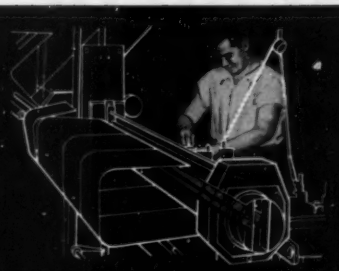
4-in-1 transmission . . .
has one speed forward, neutral, reverse and speed reduction combined into unit. 9x10x 12½-in. Transmits up to 8 hp at max recommended input speed of 3600 rpm intermittent and 3000 rpm continuous. Reduction ratio is 2.47: 1 in both forward

continued on page 189

CHROMALOX ELECTRIC STRIP HEATERS

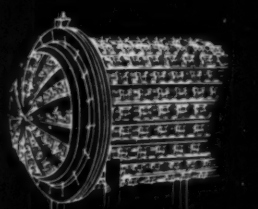
Versatile, dependable, uniform heat for your product or processing needs

Chromalox Strip Heaters, sheathed in iron, chrome steel and Monel, come in sizes and types for every need. 4" to 96" lengths, 1" to 2½" widths. Also available in full rings and segments.

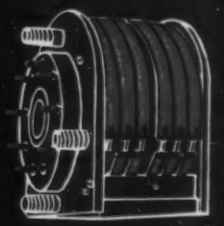


Rolls for bending plywood to form luggage case bodies are uniformly heated with long Chromalox Strip Heaters.

Zoned heat and close temperature control is obtained in grease kettle with separate groups of Strip Heaters.

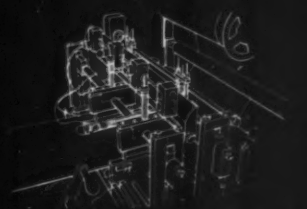


Vacuum dehydrating oven, also used as vacuum furnace at temperatures to 950° F., equipped with Type SE Strip Heaters and SR segment heaters.



Aluminum extrusion container heated by curved Strip Heaters around circumference and Chromalox Cartridge Heaters in holes closer to billet.

Brake-lining bonding oven equipped with three SE Strip Heaters and a Ring Heater to produce uniform bond.

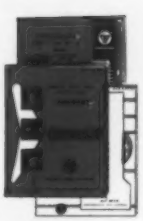


Sealing arm on platen with thermostatically controlled Strip Heaters on each side delivers constant temperatures regardless of machine speed.

Compact, metal-sheathed Chromalox Strip Heaters assure accurate temperatures, dependable around-the-clock service anywhere heat is needed for product or process. It is by far the most versatile built-in heat source available today. Easy to install—Chromalox Strip Heaters produce uniform and accurate temperatures with automatic or manual controls.

Low initial cost, low installation costs and low operating costs are among the many other advantages of using Chromalox Strip Heaters for heating tanks, platens, ovens, molds, moving parts, and similar uses. Over 500 standard sizes, shapes, ratings and terminal arrangements available immediately from stock. Get the full details now.

GET THE FACTS
Write for Industrial Processing Catalog 60, Comfort Heating Catalog F-975D, Infrared Catalog G-62.



WI-10

EDWIN L. WIEGAND COMPANY
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CHROMALOX
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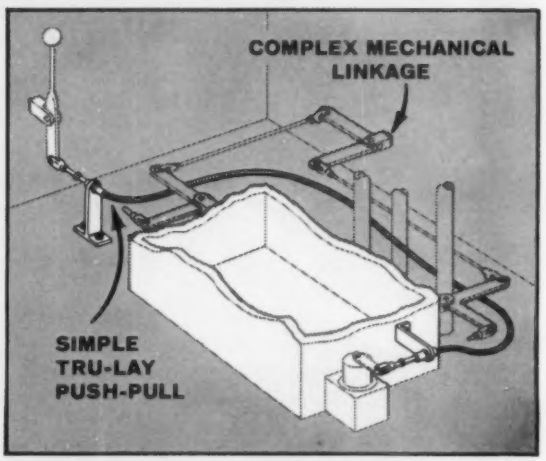
ACCURATE REMOTE CONTROL FOR HUNDREDS OF PRODUCTS

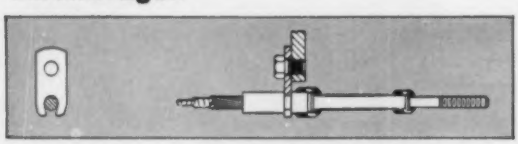
— — with Tru-Lay *PUSH*-PULL Controls

If your products involve remote control—electrical, hydraulic, pneumatic or direct—TRU-LAY PUSH-PULL FLEXIBLE CONTROLS can help solve your design problems. They provide positive remote control over short or long distances—up to 150 feet from the control point. Because they operate while flexing, they can snake around obstructions. They will not buckle. They are ruggedly constructed, easily installed and operated, sealed against dirt and moisture, and will handle jobs with as much as 1,000 lbs. input. PUSH-PULL CONTROLS are simple, have but one moving part, are noiseless and give a lifetime of accuracy. Mechanical linkages, on the other hand, are complex. Unlike PUSH-PULL CONTROLS, they are made of many parts, wear at many points, and produce increased backlash, vibration rattles and lost accuracy.

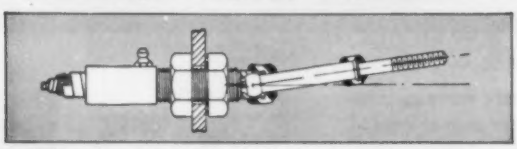


THESE FEATURES HELP SOLVE DESIGN PROBLEMS

Anchorages



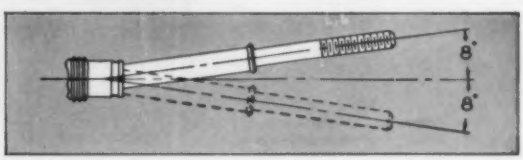
Clip anchorage • a simple clip for light loads



Bulkhead anchorage • for heavy-duty installations

Machined bracket anchorage • can be furnished for mounting any PUSH-PULL cable at the swivel terminal

Swivel Action



Standard assemblies have end fittings with a swivel movement of ± 8° to compensate for misalignment and rise or fall of lever arms. Swivel joints, and the sliding ends, are sealed against dirt and moisture.

PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY, IMPROVE DESIGN

• Write for your PUSH-PULL Data File. It contains a complete set of engineering bulletins which describe in detail the operation of PUSH-PULL CONTROLS, their applications, features and advantages.

ACCO

PUSH-PULL CONTROLS

Automotive and Aircraft Division • American Chain & Cable Company, Inc.

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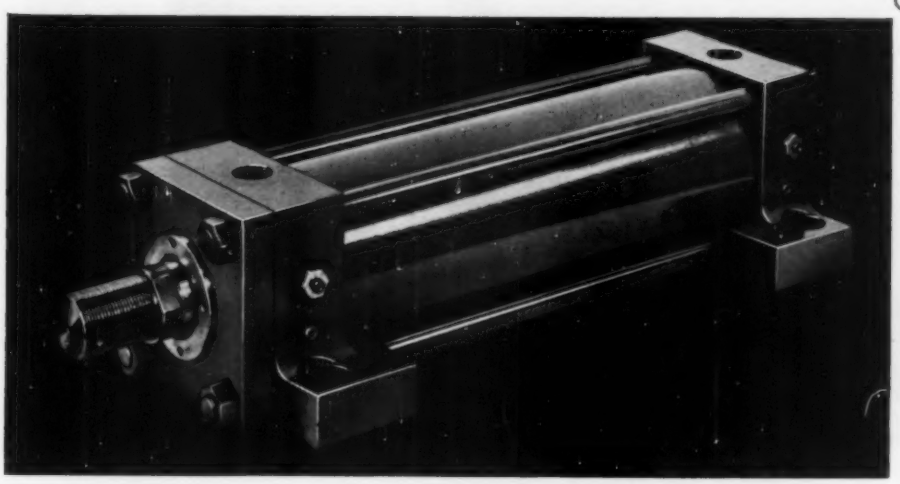
Sales Representatives from Coast to Coast



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For your convenience, Anker-Holth sales representatives have been established in 34 principal U.S. cities including Honolulu and are Ready to Serve You with your pneumatic and hydraulic power cylinder requirements. This network of specialized, factory-trained men is accustomed to tough design problems . . . hurry-up calls . . . and devotion of time and study to your proposals.

They offer you outstanding Anker-Holth custom engineering in an endless variety of applications as well as the world's most complete line of standard air and hydraulic power cylinders. Why not contact an Anker-Holth representative today! Refer to your telephone directory for the representative in your city or contact Anker-Holth directly, and a representative will be at your plant Ready to Serve You in a matter of hours.

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DIVISION, THE McDOWELL-WELLMAN COMPANIES

ANKER-HOLTH DIVISION G-3
The Wellman Engineering Co.
2723 Connor St., Port Huron, Mich., U.S.A.

Please send me more information about Anker-Holth Cylinders

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Title_____
Company_____
City_____
State_____

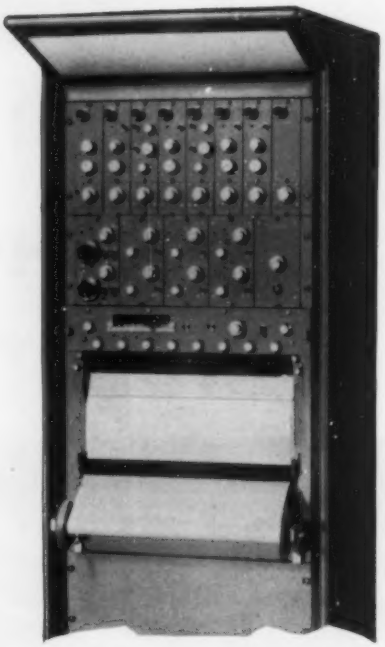
CIRCLE 187 ON READER SERVICE CARD 187

Bodine Motors Give You **ADE** (**A**fter **D**elivery **E**conomies)
Here's an example...

"We've used BODINE MOTORS for 25 years... they have proved to be very reliable"

says Dr. Franklin F. Offner
President
Offner Electronics, Inc.
Schiller Park, Illinois

The microvolt sensitivity of Offner Dynograph recorders and electroencepalographs demand motors that produce a minimum of stray field and vibration, motors that stand up under a variety of operating conditions. Offner instruments are used in hospitals where quietness is important; at sea where adequate saltwater protection must be provided, in industrial monitoring where there can be no failures in long continuous operation. Offner Electronics has specified Bodine Motors for the last twenty-five years.



Offner Type R Dynograph Assembly

As Dr. Offner puts it, "Our customers have always expected a high degree of reliability from our equipment, and we maintain rigorous testing and quality control procedures to insure such reliability. Twenty-five years experience with Bodine Motors has convinced us of the excellence of these motors, and we will continue to use them in our product design."

The ADE (After Delivery Economies) of Bodine Motors mean more years of trouble-free operation where it counts most . . . in the hands of your customers. Bodine Motors deliver the performance a quality product demands . . . provides economies that earn customer satisfaction and repeat orders. Ask for Bodine Bulletin S-2 for detailed information.

BODINE
fractional horsepower
MOTORS
. . . the power behind the leading products

Fractional Horsepower Motors for: Office computing and accounting equipment • Engineering, laboratory, and research instruments Photographic equipment • Musical instruments • Electrical industrial apparatus • Therapeutic and medical equipment • Communication equipment • General industrial machinery • Metalworking machinery Service industry machinery • Optical instruments • and any equipment that requires quality fractional horsepower electric motors

Bodine Electric Co., 2510 West Bradley Place, Chicago 18, Illinois

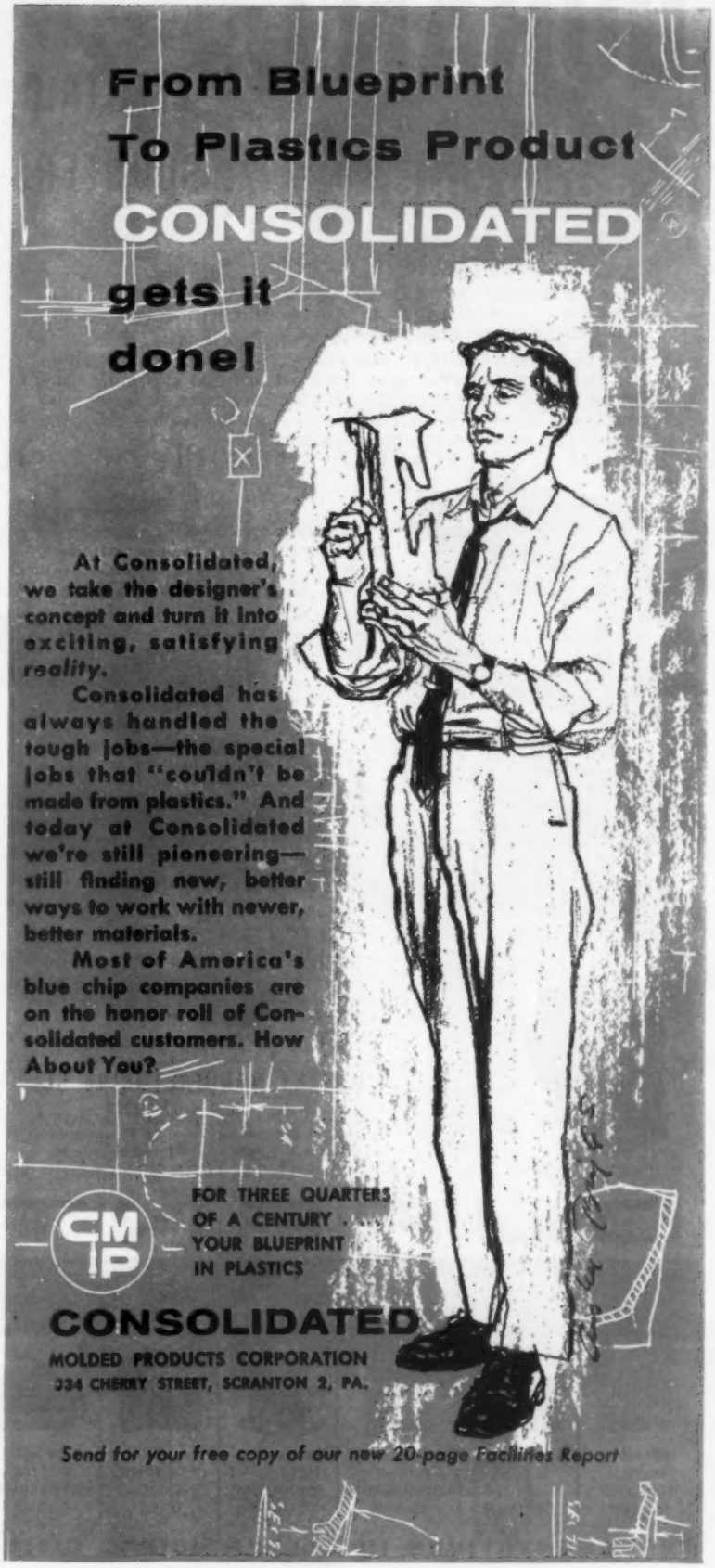
and reverse operation. Can be shifted smoothly as often as necessary, under full load or at any speed. Suggested applications include agricultural, materials handling, machine tool and construction equipment wherever reversing is needed. **Industrial Div, Snow-Nabstedt Gear Corp, Hamden, Conn.** See Booth 1039 or
Circle 341 on Reader Service Card

Integral-hp motor . . .
is made of aluminum for stronger, lighter unit and has bearing system that keeps grease in, contaminants out and prevents under- and over-greasing. Quick-connect terminal board permits motor to be shipped prewired to specified voltage and simplifies voltage changeover on dual-voltage models. Conduit box has space for overload protection devices. Both single and polyphase motors have identical NEMA frame sizes on rating-for-rating basis. Available in hp sizes from ¼ to 7½ in foot-mounted, resilient-base, face-mounted, flange-mounted and vertical-mount styles. **Franklin Electric Co, 400 E Spring St, Bluffton, Ind.** See Booth 1052 or
Circle 342 on Reader Service Card

De-gassed potting package . . .
produces completely filled modules without operation taking place in a vacuum chamber. Package contains de-gassed potting resin and curing agent, a piercing coupler, a clamp and a resin trap. All that's required is a vacuum line to evacuate mold prior to potting operation. Adaptable to many types of potting resins. **Fenwal Inc, Ashland, Mass.**
See Booth 460 or
Circle 343 on Reader Service Card

20-amp reel . . .
for electric cords powering hoists and other equipment in motion, has replaceable spring motor that can be removed without handling loose springs or dismantling reel. Tension on spring can be increased or decreased from outside by rotating housing position. Holding-dog also can be ad-

continued on page 190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Send for your free copy of our new 20-page Facilities Report

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Your answer to ACCURATE, HIGH SPEED COUNTING *by* REMOTE CONTROL

ELECTRIC COUNTERS

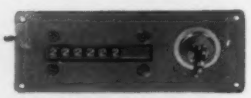
There's a standard Durant Electric Counter to fit practically any OEM application . . . enabling you to build modern electric counting into your PRODUCT, MACHINE or METHOD.

Durant's "HIGH VISIBILITY", with clean-cut legible figures set high up and close to the window, show the exact figure at a glance. Many Durant fully enclosed Electrics have been performing accurately and dependably under varying conditions for years and years — giving the reliability so necessary in a counting operation.

"Y" Electric Series
(Model 6-Y-1-MF)
1000 CPM

"CS" Electric Series
(larger size — larger figures)

Ideal for PANEL MOUNT
(placed and mounted from front) on machine or at control center



Tumbler Lock Key Reset for "tamper control"

"YE" Electric Series
Push Button Reset
(Model 5-YE-8947-Q)
1500 CPM

"Y" Electric Series
4 figure
(Model 4-Y-9434-B)
600 CPM

"Y" Electric — Small, compact; AC counters equipped with integral rectifier for high speed and long life. Records accurately at high, low, or intermediate speeds.

"CS" Electric — Same external design and features as "Y" Series, but with larger case size and larger figures . . . for more rugged, heavy duty applications.

"YE" Electric — With electric instant reset or finger-flick instant reset.

ACTUATORS and CONTACTORS
Durant offers photo-electric, lever, roller arm, star wheel, or limit switch units for use with Electric Counters.

Send for Catalog Number 55

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COUNTING INSTRUMENTS
Accurately Count Everything . . . EVERYWHERE

"YE" SERIES HERMETICALLY SEALED FOR MILITARY

MODEL 3-3-5-Y ELECTRIC COUNTERS ONE FRAME

MODEL 6-Y ELECTRIC PREDETERMINING COUNTER

PUSH BUTTON RESET ELECTRIC FOR MILITARY APPLICATION

4 FIGURE "Y" ELECTRIC PANEL MOUNT

"SP-MF" ELECTRIC PREDETERMINED COUNTER

REPRESENTATIVES IN ALL PRINCIPAL CITIES

justed from outside by moving special cam arm. Reel includes $\frac{7}{16}$-in. steel frame, 18-gage steel drum, and one-piece brush assembly which provides full-contact, longer, wider brushes. Brush and collector assembly is 4-pole type, arranged so that extra brushes can be removed or used for higher amp requirements in parallel connections. Collector rings are interlocked to prevent shearing of lead wires. Designed for voltages to 550 ac, 250 dc. Handles Type S and SO cord, 2, 3, 4 conductor, No 18, 16, 14 and 12 sizes. Available in two models for cords 25 to 45 ft long. **Gleason Reel Corp, 800 Horicon St, Mayville, Wis.**

See Booth 1015 or
Circle 344 on Reader Service Card

Low-pressure sensing switch . . .

handles max set pressure of 7 psig and has deadband of only 2 in. of water. Repeatable accuracy is ±0.5%. Uses capsular type sensing element (eliminating conventional connecting linkages) to reduce any change in pressure set point by thermal reaction over −65 to 300 F range. Weighs approx 2 oz and occupies 3 cu in. space. SPDT snap-action switch, enclosed in the cylindrical housing, handles 7 amp at 115/230 v ac. Unit available with AN electrical connector or cabled leads and solder terminals. Pressure ports are standard $\frac{1}{4}$ NPT male fittings (AN fittings on request). **Pamar Electronics Co Inc, Sub of Hoke Inc, 1 Tenakill Park, Cresskill, NJ.**

See Booth 455 or
Circle 345 on Reader Service Card

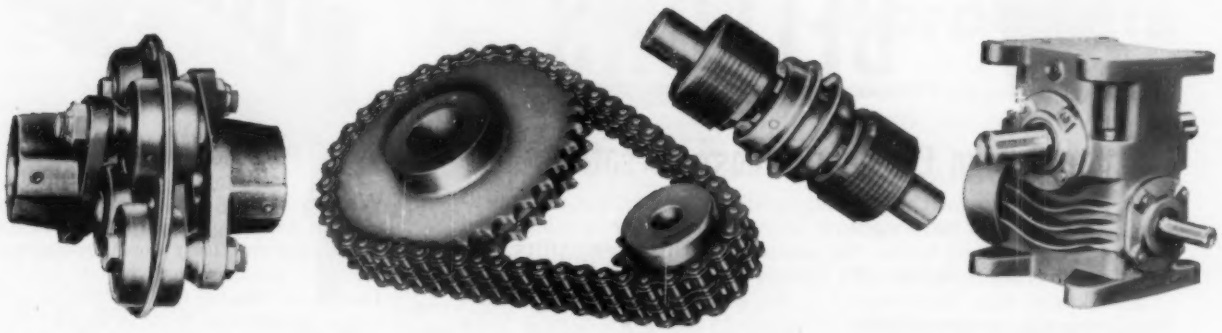
Metered flow-control pump . . .

has positive-displacement rubber impeller in 316 stainless steel housing. Measures and transfers fluids and semifluids of widely varying viscosities and densities with metering accuracy of 0.5%. Dual pump head

continued on page 192

Morse has an answer to every industrial drive problem under the sun

Basic Drives, Speed Reducers, Couplings, Clutches—only Morse makes all four and only Morse stocks all four. For example, if your industrial drive problem involves basic drives such as roller chain, silent chain, and Hy-Vo® Drives, or "Timing"® belts, friction clutches, and couplings, too, look to Morse for the answer. You'll get impartial engineering help and immediate delivery.



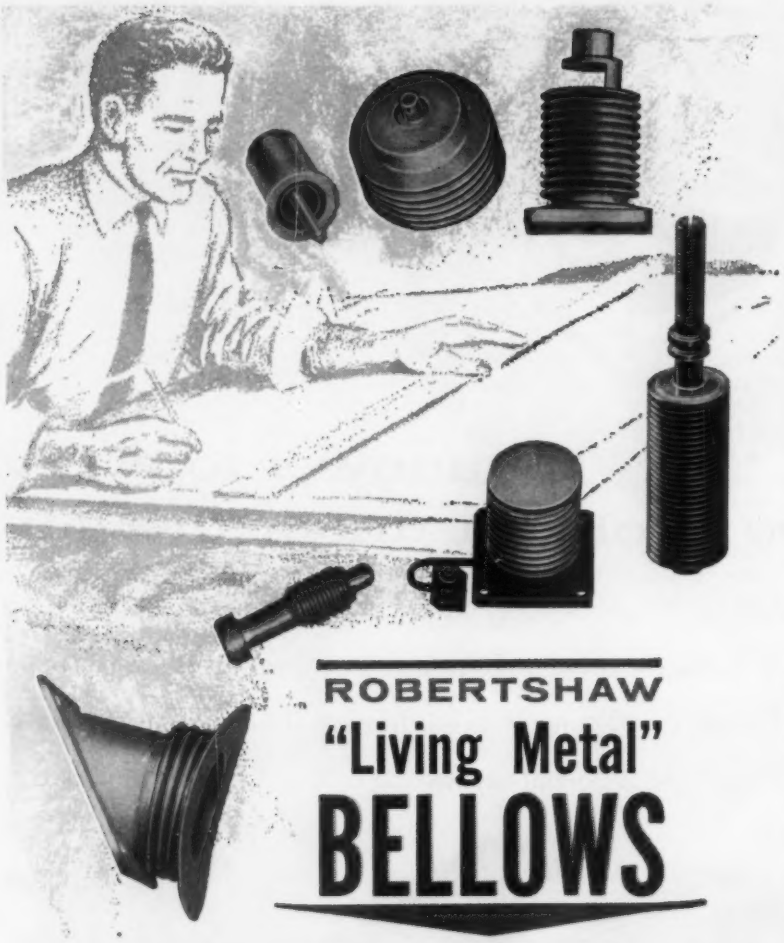
As for quality, Morse products speak for themselves: Morse timing chain is original equipment in over 76% of American cars. So whatever your industrial drive problem, see your Morse man. He's in the Yellow Pages. Or write: Morse Chain Co., Dept. 4-51, Ithaca, N.Y. Export Sales: Borg-Warner International, Chicago 3, Ill. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ont.

MORSE

A BORG·WARNER INDUSTRY

B·W

CIRCLE 191 ON READER SERVICE CARD



ROBERTSHAW

"Living Metal"

BELLOWS

. . . "the Design Engineer's Most Versatile Aid!"

As a DE you know the critical conditions of stress, temperature, pressure or atmosphere that make your problem so difficult . . . but you know the almost limitless versatility you can expect from Sylphon (R) Bellows by Robertshaw.

You know, too, that once you have worked out your exact requirements, our own bellows engineers can work closely with you to develop practical specifications and then carry the ball to final delivery.

Working with a variety of metals—brass, monel, beryllium copper, inconel, inconel-X, phosphor bronze, stainless steels, Ni-Span-C and others—they give you a bellows or bellows assembly with the precise, controlled expansion quotient your need demands.

Many Design Engineers call a Robertshaw Bellows their most dependable aid in aircraft, missile and process applications. Ours was the first seamless metal bellows ever made: today, we're still making the best.

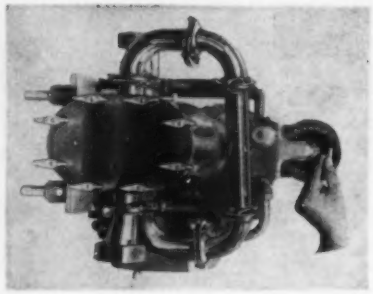
For design data and tables of physical properties, write today for Catalog JP-R.

Robertshaw

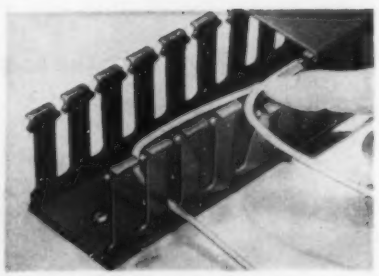
MR. CONTROLS

Robertshaw-Fulton Controls Company

FULTON SYLPHON DIVISION, KNOXVILLE 1, TENNESSEE



permits internal equalization of pressures to reduce slippage and keep volumetric efficiency between 99.5% and 99.7%. May be used in liquid-level control; temperature control of process steam; flow-rate control using punched card or tape; mass-flow control of continuous operations, etc. **Waukesha Foundry Co, Waukesha, Wis.** **See Booth 616 or**
Circle 346 on Reader Service Card



Wiring duct . . .
made of nonflammable vinyl, has flexible fingers separating entry slots, eliminating need for threading wire through holes. Duct cover snaps off for inspection or revision. Material may be cut to length with fine-tooth hand or power saw. Corner, tee, transition and straight-through fittings are available. Duct may be mounted with screw through a hole drilled in duct base, with spring clips, or a threaded stud through duct and cover. Meets JIC requirements. Available in 5- or 6-ft lengths in white, black, dark or light gray. **Panduit Corp, Dept PE, 17301 Ridgeland Ave, Tinley Park, Ill.** **See Booth 1217 or**
Circle 347 on Reader Service Card

Fastener head . . .
has three equally spaced driving slots on its outer periphery, requiring a special tool for driving and loosening. Result is tamper-proof fastener suitable for distributor heads and electrical boxes. When fastener is driven, forces are on outer periphery instead of in center, eliminating head distor-

UNIFORM TUBING
always available

ALLOYS
Almost any analysis, including aluminum alloys — 1100, 3003, high purity, 2024, 5052, 6061, 6951 and the new high strength alloy UT58; copper alloys—OFHC Copper, Phosphor Copper, 70/30 Brass, Yellow Brass, Red Brass, 18% Nickel Silver, "A" Phosphor Bronze, #25 Beryllium Copper, 30% Cupro Nickel; Nickel alloys—"A" Nickel, Monel, Inconel; Stainless Steels—304, 310, 316, 321, 347, 410; Glass-to-Metal Sealing alloys — #52 Nickel-Iron, "Rodar"; Precious Metals.

SIZES
O.D. from .625" to .005". Wall thicknesses down to .001".

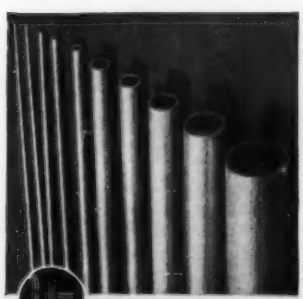
TOLERANCES
Commercial or precision—down to ±.00025" on smaller tubing.

FABRICATION
Have your tubular parts "made at the mill"—by skilled tubing fabricators, on specially designed tools in our extensive forming and machining plant.

Cut subcontracting cost, concentrate responsibility, get better delivery and better parts, ready for assembly.

Write for new catalog.

FAST DELIVERY



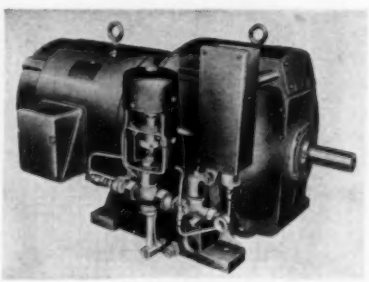
UNIFORM TUBES, INC. COLLEGEVILLE 2, PA.
HUxley 9-7276 TWX-CGVL 1044

tion through worn driver bits. Also has a large driver contact area, which helps prevent driver slippage. **Reliance Div, Eaton Mfg Co, Massillon, Ohio.**

See Booths 656, 660, 662 or
Circle 348 on Reader Service Card

Steel conveyor chains . . .

are equipped with Delrin-bushed rollers and stainless steel bushings, said to extend chains' service life. Rollers need little or no lubrication and reportedly resist corrosion better than stainless steel ones. Also operate quietly and can be continuously cleaned with water at temperatures up to 180 F (can be steam cleaned when necessary). Chains with new rollers range from 3.000 to 6.000 pitch. Each type is said to replace an average of 10 competitive types and sizes of cast roller chains. **Chain Belt Co, Milwaukee 1.** See Booth 929 or
Circle 349 on Reader Service Card



Variable-speed drives . . .

are uprated in five sizes. One model, formerly rated 40 hp at 1800 rpm, now is rated 75 hp. Torque capacity also has been increased in the watercooled eddy-current drives, while magnetic system used to generate eddy-current has been improved by more efficient use of magnetic fields. Priced same as previous models. **Dynamatic Div, Eaton Mfg Co, Kenosha, Wis.**

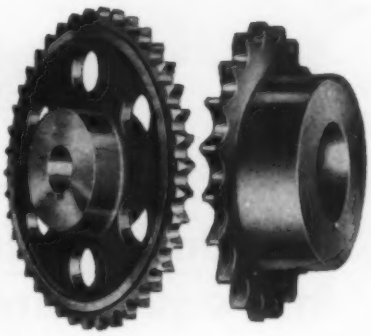
See Booths 656, 660, 662 or
Circle 350 on Reader Service Card

Splice caps . . .

have "see-through" nylon insulation with extra long skirts for max grounding and short circuit protection. Requires no wire twisting and handles wide range of wire sizes, including 2 through 6 #18 stranded; 3 through 5 #18 solid; 2 or 3 #16 stranded or solid; 2 #14 stranded or solid; and 1 #12 with 1 #14 stranded. UL and CSA listed for 600 v max in building wire and 1000 v in fixtures—to

continued on page 194

A Morse answer



roller chain
sprockets

. . . when the problem involves quality, cost and performance

Made to A.S.A. standards

Chain-maker quality

Precision pitch control

Controlled concentricity of bore, hub, and teeth

Advanced heat-treating processes

Face runout minimized by exclusive flattening process

Distributor-stocked

Got a sprocket problem? Call your Morse distributor. He's listed in the Yellow Pages.

MORSE
A BORG-WARNER INDUSTRY

Morse Chain Co., Dept. 4-51, Ithaca, N.Y. Export Sales: Borg-Warner International, Chicago 3, Ill. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ont.

Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD 66DD.

DUFF-NORTON COMPANY
Four Gateway Center · Pittsburgh 22, Pa.

DUFF-NORTON JACKS
Ratchet • Screw
Hydraulic • Worm Gear

DUFF-NORTON

COFFING HOISTS
Ratchet Lever • Air
Hand Chain • Electric

221 F. Can be crimped by hand or pneumatically-operated ratchet-controlled tool. Three-indent rolling action minimizes puncture, splitting or thinning-out of insulation. **Buchanan Electrical Products Corp, Hillside, NJ.**

See Booth 720-726 or
Circle 351 on Reader Service Card

Cylindrical roller cage assembly . . .
is lighter in weight than competitive types. Hardened cage design gives greater thrust and thrust-rubbing characteristics. Available in sizes to fit standard roller bearing series. **Aetna Ball & Roller Bearing Co, 4612 Schubert Ave, Chicago 39.**

See Booth 213 or
Circle 352 on Reader Service Card

Pressure-gage protector . . .
for gas service only, provides max set pressure protection point of 1000 psig and handles inlet pressures up to 3000 psig at —10 to 200 F. Three range springs cover 30 to 150, 150 to 500 and 500 to 1000 psig. Inlet and outlet connections are both ¼ NPT female, permitting gage to be threaded directly to protector. Once set, protector remains fixed and immediately

not
just balls
but
precision
balls
made from
many
materials
with
finer
finishes
and closer
tolerances

Don't let our name
Hartford Steel Ball confuse you.
Yes, we make steel balls,
but more than that we have
researched and developed other
precision balls, balls of a wide
variety of materials,
balls that meet the exacting
new production demands.
Our facilities and experience are
at your service. There are
Hartford sales engineers in
Major U.S. cities and Canada.
Let us recommend the ball for
you before you find you
have a problem.
Our newest and most complete
ball catalog is a handy reference
for quick precision ball selection.
Just sign your name to
your company letterhead and
address to us. A copy will be
mailed promptly.

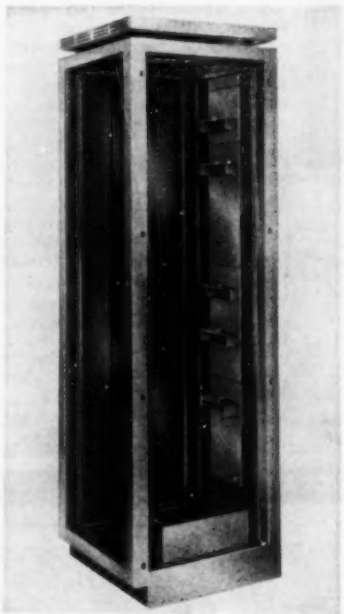
Specify Hartford PRECISION BALLS • BEARINGS

Hartford Steel Ball Company
45 Jefferson Ave., West Hartford, Conn.

CIRCLE 259 ON READER SERVICE CARD

stops flow to gage when pressure protection point is reached. Reset is automatic when pressure drops below point. Measures $1\frac{7}{8}$ in. long and has brass body and piston and Buna-N O-rings. **Hoke Inc, 1 Tenakill Park, Cresskill, NJ.**

See Booth 455 or
Circle 353 on Reader Service Card



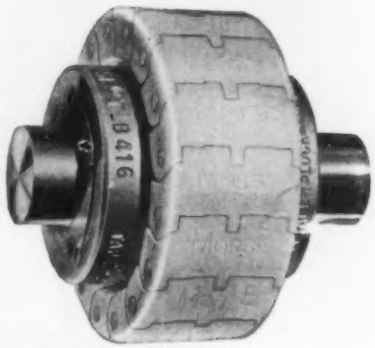
Electronic rack cabinet . . . made by standard tools and dies, is suitable for modular unit expansion. Adjustable channels facilitate mounting slides or chassis, and hinged rear door allows easy access to internal components. Adjustable scoops in duct outlets (which can be positioned vertically anywhere desired) permit regulation and balancing of air discharge to ventilate chassis or components. Dimensions are 77x24x24 in. and construction is of heavy-gage, cold-rolled steel or aluminum finished to specifications. **Falstrom Co, 185 Falstrom Ct, Passaic, NJ.**

See Booth 821 or
Circle 354 on Reader Service Card

Parallel-shaft gearmotor . . . totally enclosed for cleaning case, has smooth exterior with no flats or crevices, stainless steel shaft extension, wipe-on gear lubricant and adhesive-type metal nameplate. Originally designed for dairy industry, unit is suitable for agitators, mixers, small conveyors and pumps. Speeds are 30, 33, 36, 60, 66 and 72 rpm, utilizing both single and two-speed motors. Avail-

continued on page 196

A Morse answer



Nylon couplings

. . . when the problem involves corrosion, cost, lubrication

Corrosion-resistant
Cost 20% less
Lubrication-free
Safety first
Easy disassembly
Standard stock sprockets
Fractional to 40-hp. loads
Speeds up to 5,000 rpm.
Distributor-stocked

Got a coupling problem? Call your Morse distributor. He's listed in the Yellow Pages.

MORSE
A BORG-WARNER INDUSTRY
BW

Morse Chain Co., Dept. 4-51, Ithaca, N.Y. Export Sales: Borg-Warner International, Chicago 3, Ill. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ont.

CIRCLE 195 ON READER SERVICE CARD

ASK THE MAN WHO USES NORDSON AIRLESS

"We cut our paint bill more than $12,000 the first 3 months!"

Mr. Briggs, left and Mr. Gering of Berry Door Corporation watch automatic spraying of steel garage doors.

"Paint costs were getting out of hand. The sales department wanted a better finish on our metal garage doors, but we were also under pressure to hold the line, costwise. After a careful investigation we switched to the Nordson Hot Airless Spray System. Results were outstanding. We effected 45 percent savings in paint and at the same time increased coverage very substantially and improved appearance. Total savings are now running better than $4,000 a month."

This is a direct report from Mr. C. T. Briggs, Chief Engineer, and Mr. L. N. Gering, Production Manager of the Berry Door Corporation, Birmingham, Michigan, world's largest manufacturer of metal garage doors.

If you spray varnishes, paints, lacquers or other industrial coatings, it will pay you to find out if the Nordson System can provide savings and improve quality for you. Write Nordson Corporation, 86 Jackson Street, Amherst, Ohio.

Nordson Model 15000 Hot Airless Spray Unit is the most versatile "paint shop" developed for American industry.

NORDSON•ORIGINATORS OF AIRLESS SPRAY

Mono Cord
NO SPLICE RINGS
are better because the principle hazard found in ordinary seal rings and belts has been removed by Western's Mono Cord one-piece construction. In addition, dimensional requirements are maintained, quality controlled, and service vastly improved—all at no extra cost.
Don't use a spliced ring for technical seal applications, but profit from nearly 60 years experience—specify Mono Cord rings by Western.
Write or phone for information, literature or a visit by our sales engineer in your area.
Mono Cord
SINCE 1902
WESTERN RUBBER CO.
GOSHEN 9, INDIANA
Molded and Lathe-Cut Rubber Parts for All Industries

able in fractional hp capacity and shaft extension in mounting styles for most applications. **Franklin Electric Co Inc, 400 E Spring St, Bluffton, Ind.**

See Booth 1052 or
Circle 355 on Reader Service Card

Chain idler . . .

is one-piece sealed ball-bearing unit used as tightener or direction changer. Rubber seals keep lubricant in place, and tooth configuration provides positive drive. Outer halves are hardened for good wear resistance. Available in wide variety of tooth configurations to fit both roller and detachable chain. **Aetna Ball & Roller Bearing Co, 4612 Schubert Ave, Chicago 39.**

See Booth 213 or
Circle 356 on Reader Service Card

Double-pole toggle switches

are rated: 20 amp, 125 v ac, 1½ hp; 20 amp, 250 v ac noninductive; 10 amp, 250 v ac, 2 hp; UL approved 10 amp, 125 v ac, "L" rating. Terminals are either spade, screw or solder types and choice of circuitry in DP switches include a ST; DT-

FORD CAB PARTS

naturally better, when made of

MOLDED FIBER GLASS*

FOR MANY REASONS...

- ✓ **Can't rust or corrode** — unaffected by weather or salt.
- ✓ **Can't be dented, or get out of shape;** highly resistant to impacts. Severe blows cause local damage only. Easily repaired. No distortion of adjacent parts.
- ✓ **Weighs up to 40% less** than equivalent sheet metal, yet is even stronger. Carries more payloads than metal cabs of comparable size.
- ✓ **Can be contour molded** into more intricate designs; larger molded units.

Secret of MFG strength is in matched-metal-die molding. Ask for free literature; details about molding MFG for YOU.

*Ford parts made by MFG include grille panel, headlight panels, side skirts and sleeper compartment.

MOLDED FIBER GLASS BODY COMPANY

4623 Benefit Avenue • Ashtabula, Ohio

center off; DT—no off; DT, momentary; ST, momentary; DT, one side on, one side momentary, no off; and DT, one side on, one side momentary, center off. Impact-resistant, molded phenolic housing measures 1.237 in. from front to end of spade; 1.2 in. long and 0.762 in. wide. **Electrical Div, McGill Mfg Co Inc, Valparaiso, Ind.**

See Booths 1031 and 1037 or
Circle 357 on Reader Service Card

Teflon-filled asbestos . . .

has high termal expansion coefficient and low resistance to deflamation under loads, particularly at elevated temperatures. Can be used in —425 to 500 F range with reportedly "excellent" torque retention. Said to be inert to most chemicals and unaffected by solvents, lubricants, hydraulic fluids or any common fuels. Solid urethane sheets, also available, include a fabric-backed sheet measuring 40 x 96 in. in over-all gages of $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{1}{4}$ in. Suitable as liner materials, sheets are said to outdistance abrasion-resisting qualities of conventional elastomers. **Auburn Mfg Co, Middletown, Conn.** See Booth 540 or
Circle 358 on Reader Service Card

Adjustable-speed drive . . .

consists of magnetic amplifier controlling two thyratrons in a full-wave circuit. Has reversing and dynamic braking and is available in integral hp ratings of 1. through 3 in size 3 and 3 through $7\frac{1}{2}$ in size 4. Speeds are 1750 to 2200 rpm in size 3 and 1750 rpm in size 4. Prices range from $710 to $2100. **Cleveland Machine Controls Inc, 1155 Brookpark Rd, Cleveland 9.** See Booth 336 or
Circle 359 on Reader Service Card

Filing system . . .

comprises 4, 6 and 8 tube modules with 4-, $2\frac{3}{8}$- and $1\frac{7}{8}$-in.-dia tubes. All modules are $18\frac{3}{4}$ in. wide to permit stacking any size. Individual tubes are paper laminate, foil-wrapped with steel ends and are anchored mechanically in metal frame. Module doors swing up or down and are held in open or closed position by spring tension without latches or catches. Stacking to any height is done using clip interlocking devices. Module lengths vary in 6-in. increments from 24 to 60 in. Heights vary according to tube diameter—4-tube unit is $5\frac{1}{8}$ in. high; 6-tube unit, $3\frac{7}{8}$ in. high; and 8-tube unit, $3\frac{1}{16}$ in. high. **Hamilton Mfg Co, Two Rivers, Wis.** See Booth 620 or
Circle 360 on Reader Service Card

A Morse answer

Torque limiters

. . . when the problem involves automatic overload protection

Protect expensive equipment

Eliminate shear pins

Lessen costly downtime

Adaptable to any drive

Easily adjusted

Controlled torque setting

Capacities: 10 to 6300 ft.-lbs.

Clutch sizes: 3 to 20 inches

Distributor-stocked

Got a clutch problem? Call your Morse distributor. He's listed in the Yellow Pages.

MORSE

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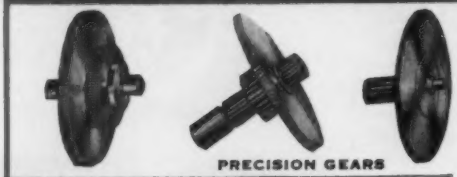
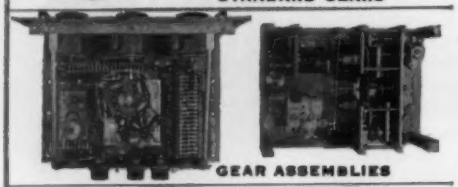
FOR YOUR PRECISION AND SPECIAL GEARING REQUIREMENTS . . . LOOK TO **Arch**

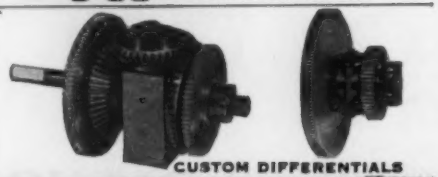


PRECISION GEARS

STANDARD GEARS



GEAR ASSEMBLIES



CUSTOM DIFFERENTIALS

ARCH

IN PRECISION GEARING Arch Gear offers you a thoroughly skilled group of gear specialists operating the latest in gear cutting and processing equipment to produce to your specifications all types and classes of precision gears at low unit costs . . . . .

IN STANDARD GEARS, the facilities of Arch Gear are perfectly suited to augment your organization in the production of large commercial gears or close tolerance manufacture of special production-type precision gears . . . . . .

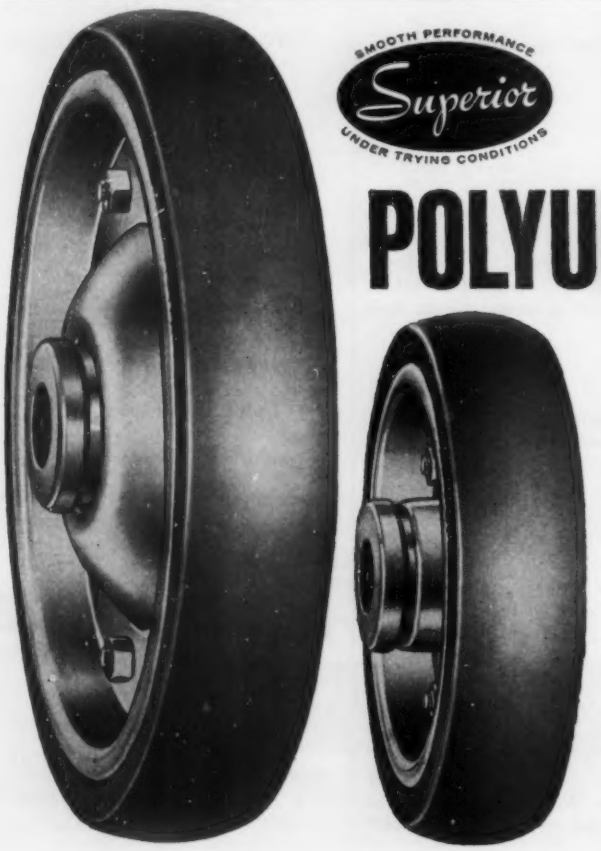
CUSTOM DIFFERENTIALS are a product of Arch Instrument, a separate manufacturing entity devoted to meeting the needs for space-age tolerances. With ten models from 1/16" to 5/16" in both hollow and solid shaft units, Arch offers you the most advanced line of differentials available. Assembly, testing, calibration and packaging is performed in a specially constructed white room to assure specified tolerances and performance.

IN GEAR ASSEMBLIES, another specialty of Arch Instrument, we offer you complete design and engineering assistance on gear trains and other servo gear assemblies. From a pilot model to a large number of production units, Arch is equipped to produce to exacting specifications as well as perform the assembly and testing of the complete electro-mechanical package . . . . . .

Why not investigate the gearing abilities of Arch? Write for complete information and literature today . . . . . .

ARCH GEAR WORKS, INC.
97 HOLMES STREET, NORTH QUINCY 71, MASS.
ARCH INSTRUMENT CO., INC.
101 HOLMES STREET, NORTH QUINCY 71, MASS.

CIRCLE 261 ON READER SERVICE CARD



SMOOTH PERFORMANCE *Superior* UNDER TRYING CONDITIONS

STEEL DISC WHEELS WITH REPLACEABLE POLYURETHANE TIRES

- ◆ Polyurethane lasts up to 10 times longer.
- ◆ It is strongly resistant to oils, most detergents, mild acids, and alkalis.
- ◆ It does not stain or mark light-colored asphalt or vinyl floorings, even under heavy loads.
- ◆ Its lasting resiliency is kind to all floor surfaces.
- ◆ Its high shock-resistance protects loads from damage.
- ◆ It rolls easily under the heaviest loads, due to its low coefficient of friction.
- ◆ Clincher-type plates simplify tire changing.
- ◆ Hyatt roller bearings provide a smooth ride for heavy loads.
- ◆ Cadmium plating protects steel discs.

These and other Superior quality wheels and casters are sold by materials handling distributors everywhere. Or write to address below for prices.

Jarvis J&J **AND Jarvis**

DIVISION OF UNITED SERVICE EQUIPMENT CO., INC.
Palmer, Massachusetts

In Canada: Jarvis & Jarvis of Canada, 1722 William St., Montreal, Que.

198 CIRCLE 198 ON READER SERVICE CARD

CATALOGS AND BULLETINS

At the 1960 DESIGN SHOW

Literature described below is available at the Design Show (see booth numbers below each item); or may be requested on our regular Reader Service cards, inside back cover.

POSITIVE-DRIVE BELTS AND PULLEYS—Brochure 7975-B1, 68 pp. Traces construction and advantages. Tabulates speed and hp capacities and center distances of stock sizes, ranging from ¼ to 1¼-in. pitch. Worthington Corp, Mechanical Power Transmission Sales Dept, Oil City, Penna. See Booth 308 or
Circle 361 on Reader Service Card

PACKINGS AND GASKET MATERIALS—Catalog P-100, 64 pp. Outlines mechanical packing recommendations for reciprocating rods and plungers; Teflon products; packing valve stems; packing centrifugal and rotary shafts, etc. Describes, illustrates and gives specifications of molded hydraulic and pneumatic packings; plastic packings; such Teflon products as stuffing box packing, sheets, tubes and rods, 0-rings, etc; and gasket materials, including woven and compressed asbestos sheet, silicone rubber sheet, etc. Raybestos Manhattan Inc, Packing Div, Passaic, NJ. See Booth 918 or
Circle 362 on Reader Service Card

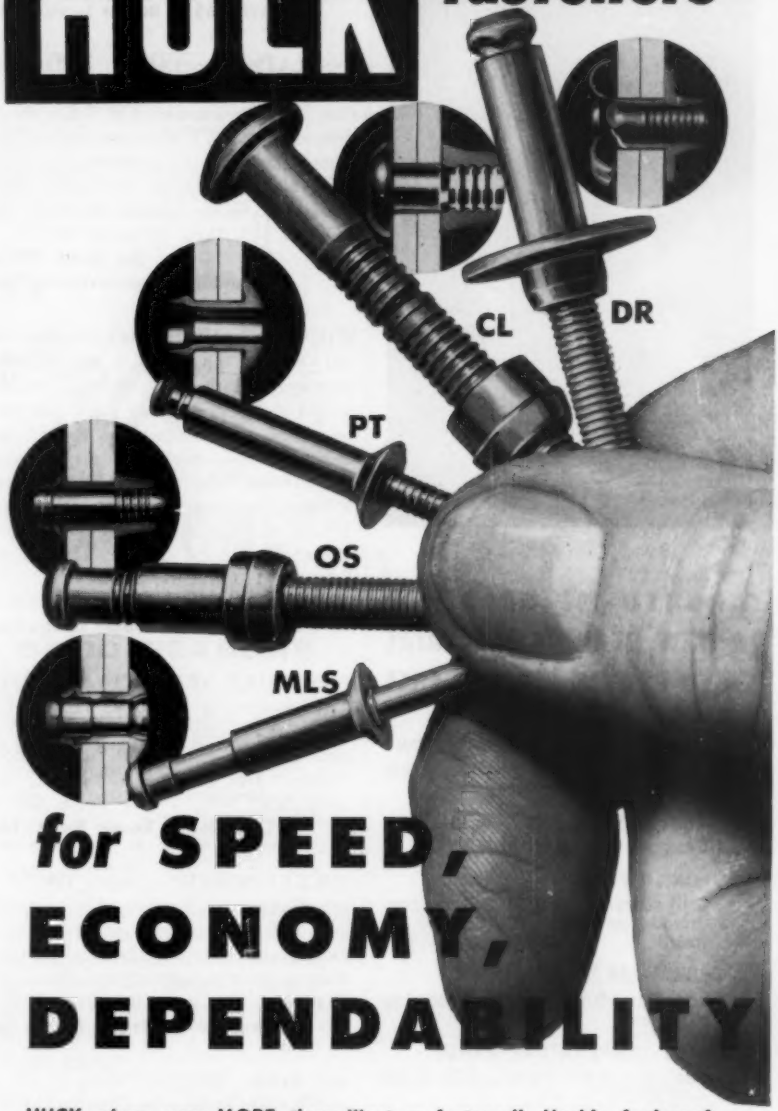
FLUID-SYSTEM COMPONENTS—Catalog 250, 140 pp. Provides dimensional and functional data on 24 types of hoses and fittings; adapters; self-sealing couplings; and hand and power equipment for hose assemblies. Specifications, such as pressures, temperatures, bend radii, etc., are included. Aeroquip Corp, Jackson, Mich. See Booth 619 or
Circle 363 on Reader Service Card

V-PULLEYS—Catalog 28103, 14 pp. Dimensions and stock bores are supplied for fixed and variable speed V-pulleys in cast iron and pressed steel. T B Wood's Sons Co, Chambersburg, Penna. See Booth 901 or
Circle 364 on Reader Service Card

REVERSING TRANSMISSION—Brochure 5231-161, 5 pp. Discusses performance and design features of unit which combines two forward speeds, neutral, reverse and reduction gear in single housing. Includes outline drawings, power

continued on page 200

HUCK fasteners



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rating curves, and installation diagrams. Snow-Nabstedt Gear Corp, 251 Welton St, Hamden, Conn. See Booth 1039 or
Circle 365 on Reader Service Card

INSULATION TAPES, COATED YARNS—Folder, 24 pp. Covers applications, properties and sizes of Teflon skived sintered tape and Teflon, vinyl and silicone-coated glass tapes. Dimensions and tolerances also are supplied for Teflon rods, sheets and tubes. Chemo Products Inc, PO Box 169, West Warwick, RI.
See Booth 332 or
Circle 366 on Reader Service Card

SHEAVES AND V-BELTS—Brochure 8015-B1, 20 pp. Carries specifications, photographs and outlines drawings of lightweight sheaves (including stock cast iron, machined steel and cast iron bored-to-suit and machined steel and pressed steel bored-to-suit units) and light-duty (fph) V-belts. Data is given for selecting proper V-belts drive in four steps. Worthington Corp, Mechanical Power Transmission Sales Dept, Oil City, Penna.
See Booth 308 or
Circle 367 on Reader Service Card

PRESSURE-SENSITIVE CLOTH TAPES—Booklet 100-61-V, 12 pp. Discusses and pictures various applications and supplies government specifications. Permacel Div, Johnson & Johnson, New Brunswick,, NJ. See Booth 212 or
Circle 368 on Reader Service Card

SOCKET SCREWS—Catalog DM783, 6 pp. Carries specifications of set, shoulder and head screws, using nylon pellets as locking mechanisms. Includes cutaway drawing, showing application. Bristol Co, Waterbury 20, Conn. See Booth 1036 or
Circle 369 on Reader Service Card

ALL-STEEL REELS—Catalog C-2B, 40 pp. Provides engineering data and installation suggestions for spring reels, geared and motor-driven reels, hoist reels and accessories. Gleason Reel Corp, Mayville, Wis.
See Booth 1015 or
Circle 370 on Reader Service Card

CYLINDRICAL, FLANGE BEARINGS—Catalog 511, 12 pp. Tabulates standard sizes and discusses dimensional tolerances, press fits, running clearances, machining, speeds and loads, bearing life, etc. Arguto Oilless Bearing Co, 149 W Berkley St, Philadelphia 44. See Booth 210 or
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ELECTRICAL INSULATION MATERIALS—Catalog, 36 pp. Contains technical descriptions, graphs and property charts on ceramoplastics and glass-bonded

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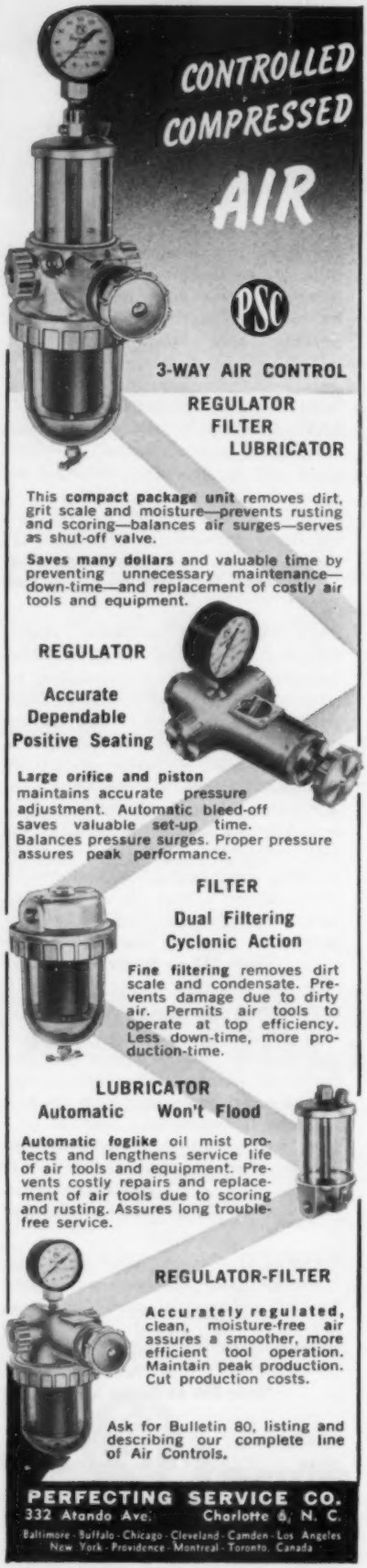
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THREAD-CUTTING SCREWS—Catalog unit 2d, 6 pp. Covers results of tests on screws' performance in cast iron, steel, aluminum and plastics. Cutaway drawings show starts, cutting action and holding power. Recommended hole sizes in metals and plastics are given. Parker-Kalon, Div of General American Transportation Corp, Clifton, NJ. See Booth 451 or
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MINIATURIZED PRESSURE SWITCHES—Bulletin HPI-161, 4 pp. Contains specifications, photographs and outline drawings of gage pressure switches, including explosionproof units, with max settings of 15 to 500 psig. Low pressure switches, with max setting of 7 psi, also are covered. Pamar Electronics Co Inc, Sub of Hoke Inc, 1 Tenakill Park, Cresskill, NJ. See Booth 455 or
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CERAMIC TUBES—Brochure, 12 pp. Traces physical properties of tube materials, including sillimanite and three compositions of aluminum oxide. Size ranges of cast and extruded tubes are tabulated. Coors Porcelain Co, 600 9th St, Golden, Colo. See Booth 1262 or
Circle 375 on Reader Service Card

SEALED SYSTEM SNUBBER—Bulletin, 4 pp. Discusses and illustrates operation of unit (consisting of diaphragm seal and stainless steel snubber) which protects pressure instruments in systems containing highly viscous or corrosive liquids and gases. Specifications are outlined for both seal and snubber. Chemiquip Co, 36 E 10th St, New York 3. See Booth 1200 or
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TUBE FITTINGS—Catalog 4311, 8 pp. Details dimensions of 37° flared tube fittings with straight threads, including connectors, elbows and tees. Assembly instructions are sketched. Parker Fittings & Hose Div, Parker-Hannifin Corp, 17325 Euclid Ave, Cleveland 12.
See Booth 544 or
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BRONZE BEARINGS—Catalog S60, 18 pp. Spells out dimensions of self-lubricating sleeve, flange and thrust bearings, as well as cored bar, solid bar, plate and strip stock. Includes discussions of tolerances, loads and speeds; chamfer and fillets; typical properties; installation; machining,

continued on page 203

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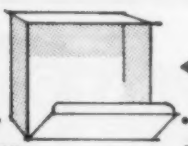

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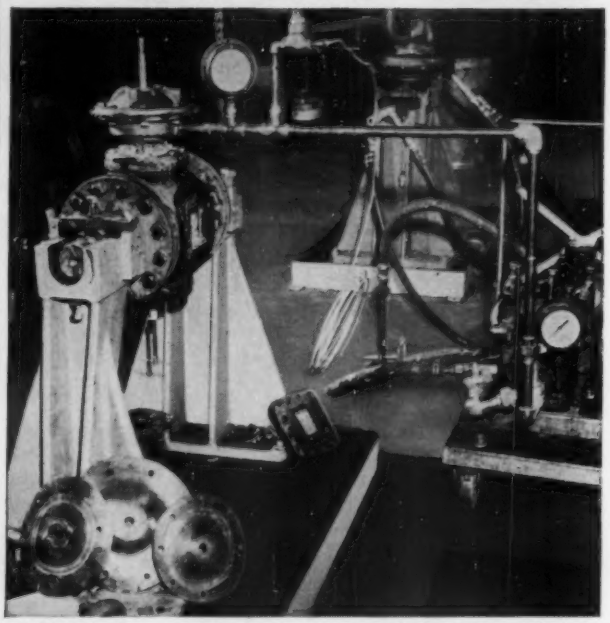

Safety tests for gas regulator diaphragms are run by Reynolds on this device fed by a hydraulic pump. Here, on an effective area of 24 sq. in., a Reevecote synthetic diaphragm safely absorbed a total thrust of 23,520 lbs.

The Reynolds Gas Regulator Co., of Anderson, Ind., takes unusual safety precautions to check the tensile strength of diaphragms in their gas regulators.

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etc. Curves show press fit values; ID close-in; and bearing clearance. Amplex Div, Chrysler Corp., Detroit 31.
See Booth 1142 or
Circle 378 on Reader Service Card

AIR-CONTROL VALVES – Bulletin 0611-B1, 4 pp. Outlines design features and pressure and size ranges of pilot-operated, 4-way units for either maintained or momentary contact electrical actuation or for remote pressure actuation. Explains how pilot valve controls main valve. Hannifin Co, Div of Parker-Hannifin Corp, Des Plaines, Ill. See Booth 544 or
Circle 379 on Reader Service Card

SUBMINIATURE CIRCUIT BREAKERS–Bulletin VP, 2 pp. Discusses performance and supplies specifications. Illustrations include circuit arrangements and dimensional drawings. Heinemann Electric Co, Trenton 2, NJ.
See Booth 1247 or
Circle 380 on Reader Service Card

MOTOR CONTROL – Bulletin, 4 pp. Contains data on ac-powered system for control of dc motors including basic features, hp range, primary power, speed-range ratio, speed regulation, power control mountings, control stations, etc. Circuitry is pictured and control station dimensions are sketched. ACF Electronics Div, 11 Park Pl, Paramus, NJ.
See Booth 1023 or
Circle 381 on Reader Service Card

POSITIVE-DISPLACEMENT PUMPS–Bulletin, 8 pp. Explains and illustrates positive displacement principle; discusses selection of proper pump construction materials; and tabulates available pump sizes, alloys and operating conditions. Viking Pump Co, 406 State St, Cedar Falls, Iowa.
See Booth 1231 or
Circle 382 on Reader Service Card

TEMPERATURE CONTROLS–Catalog G-25, 4 pp. Illustrates and lists specifications of standard-duty, heavy-duty and miniature electric units, as well as pneumatic temperature controls. Discusses their operation. Burling Instrument Co, 16 River Rd, Chatham, NJ.
See Booth 124 or
Circle 383 on Reader Service Card

MAGNETIC DRIVES–Bulletin TP2-61, 12 pp. Covers engineering principles, applications, cost-reducing advantages and selection data. Gleason Reel Corp, Mayville, Wis. See Booth 1015 or
Circle 384 on Reader Service Card

BALL VALVES AND ACTUATORS–Brochure BVHA12, 8 pp. Specifications

continued on page 204

NE-83 ACTUAL SIZE

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Design Current	10.0 m.a. d-c
Life (at 10 m.a. d-c for an average change of 5 volts in breakdown and maintaining voltage)	500 hours

*Average after 100 hours burning at rated current. Individual lots may vary from average.

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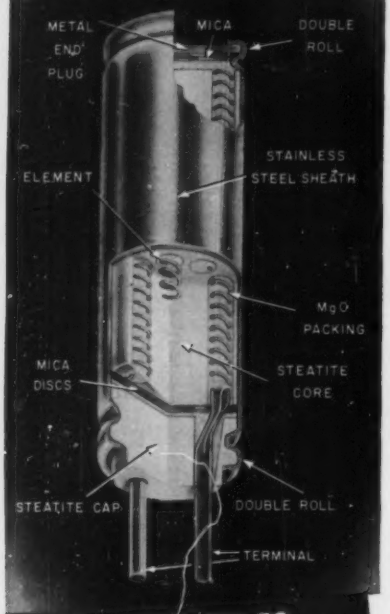

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- Plus many more standard and special features.

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and dimensional data are outlined for low- and high-pressure valves, and 2- and 3-position hydraulic actuators. Photographs and outline drawings of each are included. Electric Boat Div, General Dynamics, Groton, Conn. See Booth 709 or

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FILTER-LUBRICATOR BOWLS – Brochure NA-6, 4 pp. Series of photos displays rugged tests applied to non-shattering, transparent bowls. Specifications are listed for compressed-air-line filters and lubricators. C A Norgren Co, 3400 S Elati St, Englewood, Colo.

See Booth 910 or

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MULTIPLE CABLE AND HOSE CARRIERS–Bulletin PT-1058, 12 pp. Carries engineering and operating principles; variety of applications; and available sizes. Gleason Reel Corp, Mayville, Wis.

See Booth 1015 or

Circle 387 on Reader Service Card

AIR POWER CYLINDERS – Bulletin 0220-B1, 4 pp. Covers design features and specifications of 200-psi cylinders in 1¼ to 4½-in. bore sizes. Includes tabulated dimensions and outline drawings. Hannifin Co, Div of Parker-Hannifin Corp, Des Plaines, Ill. See Booth 544 or

Circle 388 on Reader Service Card

JUNCTION-TERMINAL BUSHINGS–Bulletin 40, 4 pp. Illustrates and spells out design features of nylon bushings that mate with ⅜- or ¼-in. standard female disconnect wire terminations. Prices are included. Heyman Mfg. Co, Kenilworth, NJ. See Booth 218 or

Circle 389 on Reader Service Card

TEMPERATURE CONTROLLER–Bulletin, 2 pp. Illustrates and lists specifications of device for remote adjustable temperature control of solids, gases and liquids. Electro-Flex Heat Inc, 83 Woodbine St, Hartford, Conn. See Booth 112 or

Circle 390 on Reader Service Card

TAPERED TUBING–Data memorandum 29, 3 pp. Discusses and illustrates construction of straight and reverse tapered tubing and tabulates size and length limits. Materials, applications and tolerances also are treated. Superior Tube Co, PO Box 191, Norristown, Penna.

See Booth 849 or

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FINNED TUBING–Data memorandum 30, 2 pp. Explains manufacture of straight and spiral integrally finned tubing and gives size range of both types, as well as information on tolerances, applications,

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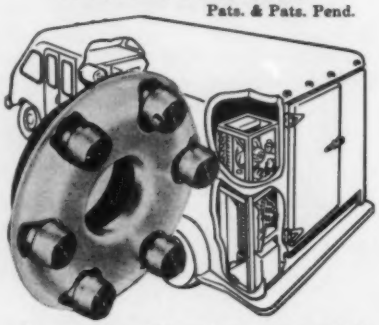

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HEAVY-DUTY CYLINDERS – Data sheet LHC-YD-1, 2 pp. Schematics and stroke and pressure graphs illustrate performance of four double-acting, single cylinder models in capacities of 50, 75, 100 and 150 tons. Owatonna Tool Co, Precision Hydraulics Div, Owatonna, Minn.
See Booth 1203 or
Circle 393 on Reader Service Card

THERMOSTATS–Bulletin 122, 1 p. Discusses construction and supplies specifications of models for use on all types of heating or cooling equipment requiring on-off temperature control or as high temperature alarms. Burling Instrument Co Inc, 16 River Rd, Chatham, NJ.
See Booth 124 or
Circle 394 on Reader Service Card

TUBING MATERIALS–Memo 121A, 6 pp. Compares characteristics and properties of columbium, tantalum and vanadium in wrought form and outlines tube sizes available in these metals. Superior Tube Co, PO Box 191, Norristown, Penna.
See Booth 849 or
Circle 395 on Reader Service Card

SINGLE-ACTING CYLINDERS – Folder, approx 8 pp. Contains dimensional drawings and data on 18 clevis- and front flange-mount, push or pull types and 6 adjustable stroke models. Mead Specialties Co Inc, 4114 N Knox Ave, Chicago 41. See Booth 839 or
Circle 396 on Reader Service Card

METERING VALVES–Catalog, 20 pp. Contains dimenisons, dimensional drawings, photographs and engineering data on metering valves, micrometer handles, poppet check valves, liquid leak detectors, plastic valves, purge valves, etc. Nuclear Products Co, 15635 Saranac Rd, Cleveland 10. See Booth 209 or
Circle 397 on Reader Service Card

FIBER OPTICS–Booklet 1212, 8 pp. Deals with, among other things, choice of materials; flexible fiberscope and tube face configurations; stray light; magnification and demagnification; fiber size, etc. Fiber Optics Sales Dept, American Optical Co, Southbridge, Mass.
See Booth 1139 or
Circle 398 on Reader Service Card

HIGH-PRESSURE CYLINDERS–Bulletin 161. Carries dimensional drawing and specifications of ¾-in. bore units for 250-psi air and 2500-psi hydraulic service.

continued on page 207

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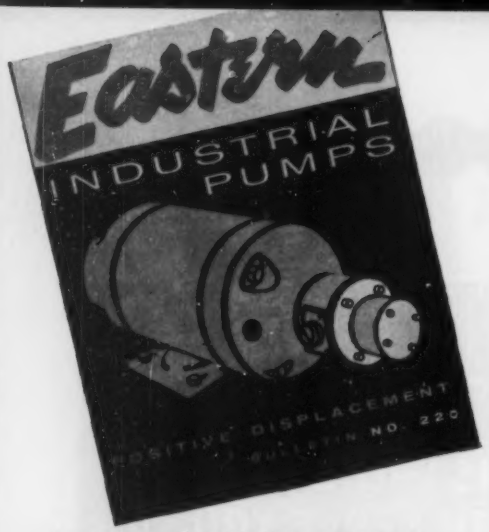

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Mounting diagrams are included. Clippard Instrument Laboratory Inc, Cincinnati 39. See Booth 1013 or
Circle 399 on Reader Service Card

AXIAL PISTON PUMPS—Bulletin 203, 8 pp. Contains performance and torque curves; schematics; and tabulated specifications. Denison Engineering Div, American Brake Shoe Co, Columbus 16, Ohio. See Booth 611 or
Circle 400 on Reader Service Card

ROLL-DRAWING FILES—Brochure A-100, 30 pp. Traces development and advantages of filing system for storing and controlling engineering tracings and other rolled documents. Pack Mfg. Co, Logan, Utah. See Booth 1238 or
Circle 401 on Reader Service Card

PUMP MOTORS—Bulletin P-86031, approx 4 pp. Provides cutaways and lists design features of two types. Dimensional drawings and data are included. Franklin Electric Co Inc, 345 E Spring St, Bluffton, Ind. See Booth 1052 or
Circle 402 on Reader Service Card

FLUSH LATCHES—Bulletin 6132A-960, 4 pp. Illustrates and gives operational features of standard and heavy-duty trigger-action types, as well as standard self-closing models. Hartwell Corp, 9035 Venice Blvd, Los Angeles 34. See Booth 915 or
Circle 403 on Reader Service Card

DRAFTING-ROOM EQUIPMENT – Catalog 11, 38 pp. Price list, 8 pp. Describes, illustrates, and provides specifications of full line from tables to T-squares. Mayline Co Inc, Sheboygan, Wis. See Booth 732 or
Circle 404 on Reader Service Card

ADJUSTABLE-SPEED DRIVES – Bulletin SL-251-161, 8 pp. Gives specifications and discusses operation and construction of size 1 thyratron tube-controlled drives. Illustrations include wiring, mounting and system variation diagrams. Cleveland Machine Controls Inc, 1155 Brookpark Rd, Cleveland 9. See Booth 336 or
Circle 405 on Reader Service Card

POWER-TRANSMISSION EQUIPMENT—Catalog 61, Sections A, B, C, and D, 22, 34, 14 and 8 pp, respectively. Containing specifications and dimensions, A is devoted to flexible couplings; B to variable speed pulleys; C, a changeover guide to variable speed belts; and D to universal joints. Lovejoy Flexible Coupling Co, 4949 W Lake St, Chicago 44. See Booth 1044 or
Circle 406 on Reader Service Card

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VEMCO

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NEW SELF-TAPPING* SET SCREW actually "Pulls Itself In"

Note how three-grooved cutting edges give full cutting tooth for easy "pulls itself in" application. Gives tight, snug fit, in plastic or metal.

- **Eliminates tapping problem!**
- **Increases product reliability!**
- **Cuts production cost!**

You can completely eliminate the tapping problem while increasing product reliability with Setko *Self-Tapping Set Screws!* Exclusive, tool-sharp, cutting edges, located on the lower threads of the screw, actually cause the screw to "pull itself in"—Shavings are gathered into the oversize slots... Holds securely even under extremes of vibration. You'll find they serve equally well to clean out painted holes or as reaming screws. Can be reapplied many times without loss of cutting or holding ability.

SEND FOR FREE TEST SAMPLES TODAY...

Tell us your requirements and we'll forward full information and recommendations, along with your samples, free of charge.

*Patent pending

SETKO Set Screw & Mfg. Co.
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We specialize in solving puzzling screw problems!

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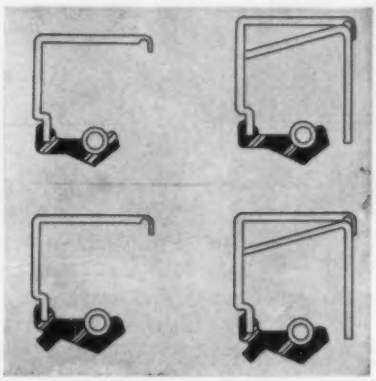
SIGNIFICANT COMPONENTS, MATERIALS, PROCESSES

Following new products are not to be exhibited at the Design Engineering Show. However, further information can be obtained, as usual, by circling corresponding number on Reader Service Card.



Shaft-type oil seal . . . consists of a spring-loaded sealing member securely bonded to the shell. As a result, there are no internal parts to misalign and no avenues for internal leakage. Member, molded of a Buna-N based synthetic rubber, has more material at points of major flex and wear without increased shaft loading. Seal has four configurations: basic design; one with an auxiliary exclusion lip; and two for larger shafts, heavy-duty service with protective inner cups. Available for shaft sizes from ½ to 7 in. **Chicago Rawhide Mfg Co, 1301 Elston Ave, Chicago 22.**

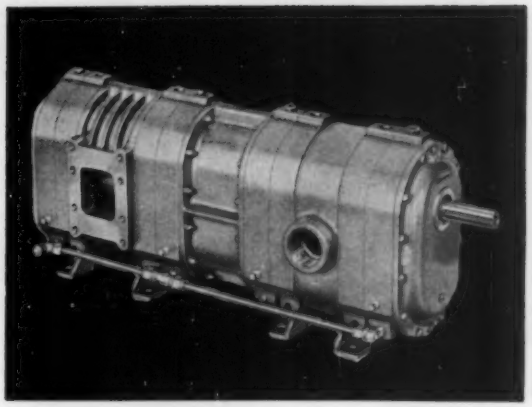
Circle 407 on Reader Service Card

Pressure-sensitive adhesive . . . air-drives to a clear, transparent film in 20 to 30 min. Even when dried, film can be peeled away by soaking with water for 1 to 2 min, causing it to lose its tackiness. Will regain tackiness if permitted to dry again. Adhesive is for Plexiglas, polyethylene, vinyl, wood, metal, fabrics, glass, etc. **Robert Langer Co, 507 5th Ave, New York 17.**

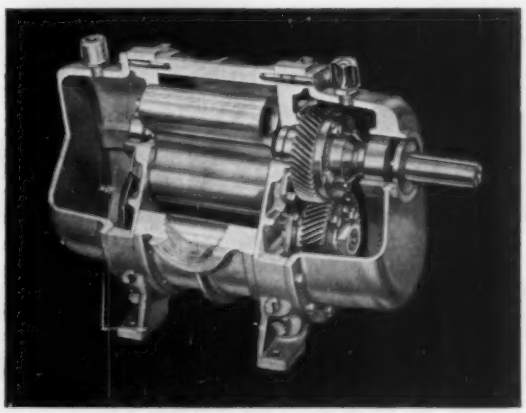
Circle 408 on Reader Service Card

Multiturn limit stop . . . is a miniature, servo-mounted unit continuously variable from 0-42 turns. External adjustment with Allen wrench varies stop range without need for disassembling unit or removing it from mount. Unit has

continued on page 211



Guaranteed Oil-free Compressed Air



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Write for complete information today.

M-D BLOWERS, INC.
Racine, Wisconsin

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Decco. INDUSTRIAL SOLENOIDS give you dependability and top performance!

- High moisture resistance
- Shock mounted for longer life
- 2 to 30 pounds—push or pull
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- Compact design
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A model for every need. Special solenoids engineered to your needs.

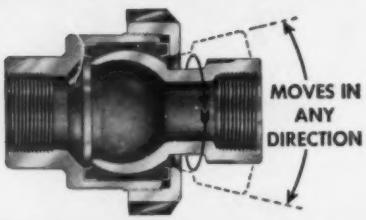
DETROIT COIL COMPANY

2435 HILTON ROAD, FERNDALE 20, MICHIGAN

CIRCLE 267 ON READER SERVICE CARD

BARCO *Flexible* BALL JOINTS

—when you need movable joints in piping handling



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In Canada: The Holden Co., Ltd., Montreal

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CIRCLE 210 ON READER SERVICE CARD

CIRCLE 268 ON READER SERVICE CARD

torque rating of 40 oz-in., with max starting torque of 0.04 oz-in. Both shaft ends have shielded stainless steel ball bearings, and shaft and all wear parts are made of passivated stainless. Measures 2 in. long and less than 1 in. dia. Weighs under 2 oz. **Components Marketing Div, Reeves Instrument Corp, Garden City, NY.**

Circle 409 on Reader Service Card

Tiny pneumatic bleed valve . . . withstands pressures up to 14,000 psi and has operating pressure of 6000 psi at —65 to 160 F. Releases with only 20 lb max of finger pressure at 6000 psi. **Benbow Mfg Corp, 11920 W Jefferson Blvd, Culver City, Calif.**

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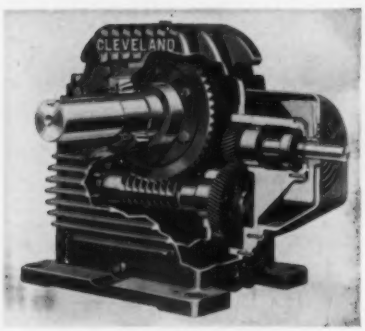

Fan-cooled speed reducers . . . have ratios extending from approx 34:1 to 394:1. Seven sizes range from 4 to 12-in. center distances, and ratings are fractional to 58.5 hp. Helical primary gears are cut from high-hardness steel, and in secondary reduction, worms are machined from medium carbon steel processed to hardness well below root diameter while maintaining advantage of a core of medium strength. Worm gears are cut from high tin-copper-content bronze and are bolted or mechanically keyed to cast iron hubs. On larger sizes, both primary and secondary gear trains share common housing, while separate housings are used on 4 through 6-in. sizes. **Cleveland Worm & Gear Div, Eaton Mfg Co, 3300 E 80th St, Cleveland 4.**

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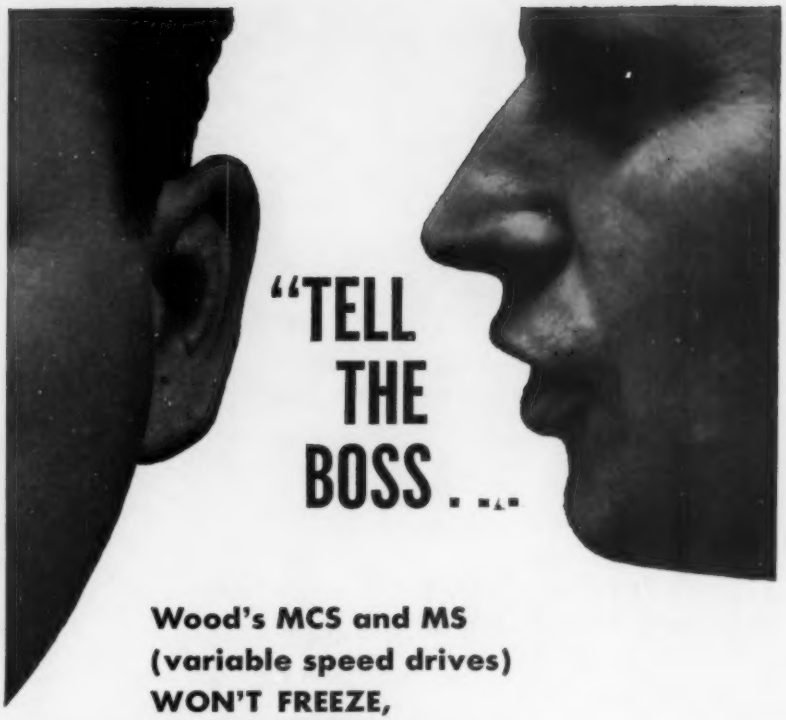
Closed-cell elastomeric sponge compares in hardness to a very soft rubber with approx 20 durometer (Shore A) rating, yet retains inert characteristics of elastomer from which it is molded. Blown version has about ¼ density of the solid

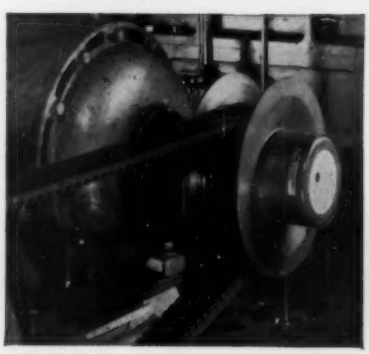
continued on page 213



Wood's MCS and MS (variable speed drives) WON'T FREEZE, WON'T STICK"

And, remind him that Wood's MCS and MS motion control drives solve production and maintenance problems no other mechanical variable speed drives can handle. They won't freeze or stick because there are no keys to obstruct lubrication of bearing surfaces. Revolutionary resilient cam followers or pads, located outside the bearing surfaces, permit continuous rotational pumping action, assure even distribution of oil. And, you check lubrication only three or four times a year. Also, Wood's MCS drives hold constant driven speeds under varying torque loads.

DON'T MISS BOOTH 901 AT THE DESIGN ENGINEERING SHOW



Wood's motion control, variable speed drives are available in capacities from fractional to 25 hp. If you and the boss want more information about these remarkable drives, write for BULLETIN 25103.

Woods

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Big oil men prefer valves by specialists

Strataflo® No. 375 all bronze check valve with poppet of silicone-treated Buna-N rubber defies damage that gasoline and oil cause to ordinary valves. Operates in *any* position: sensitive spring closes poppet automatically; flexible, can't leak; noiseless; works on low pressures. Write for Bulletin 904.

STRATAFLO PRODUCTS, INC.
4939 S. Lafayette St., Fort Wayne, Indiana

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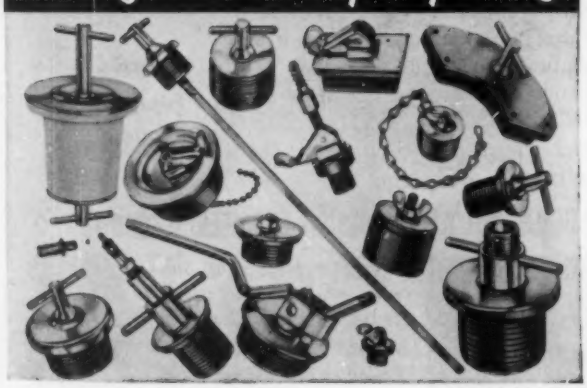
MOELLER HIGH-SPEED ADJUSTABLE CLOSURES

Fit any size or shape opening



The patented adjustable action of Moeller's Snap-Tite® and Turn-Tite® cam and lever type action closures makes it possible to design a low-cost stopper in virtually any size or shape.

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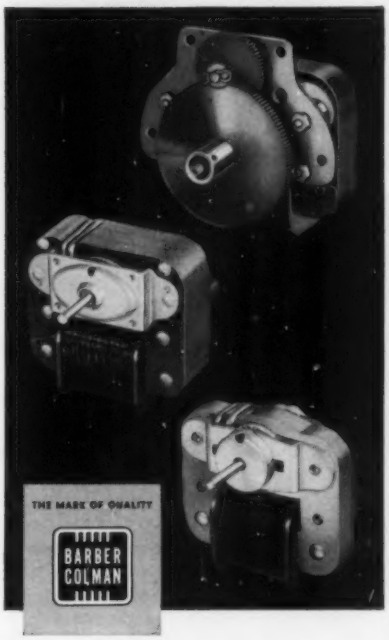
Barber-Colman unidirectional, geared and nongeared motors *(up to 1/20 hp)*



Outstanding for their high starting torque and low-inertia rotors. Precision-made for commercial and industrial applications such as appliances, vending machines, projection equipment, office machines, displays, toys, pumps, blowers, and fans. Shaded pole type, 115 volt a-c (220 volt optional) . . . up to 1/20 hp. Low noise level . . . long-life lubrication . . . high dielectric strength coils . . . stainless steel shafts . . . quality guaranteed!

WRITE FOR QUICK REFERENCE FILE
Gives typical specifications on the complete line of Barber-Colman a-c small motors: unidirectional, synchronous, reversible. With or without reduction gearing. Open or enclosed types. Stator and rotor sets also available.

BARBER-COLMAN COMPANY
Dept. Q, 1212 Rock Street, Rockford, Illinois

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elastomer. Available in sheets up to ½ in. thick and 9 in. sq, in a variety of pastel colors for such uses as: gaskets, seals and plugs when resistances to grease, oil and commercial gasoline are required; gaskets and seals in presence of perchloroethylene; vibration dampening; and insulation, made possible by materials' top dielectric properties. Other sheet sizes and simple molded shapes of both higher and lower densities can be supplied to specifications. **Minnesota Mining & Mfg Co, 900 Bush Ave, St Paul 6.**

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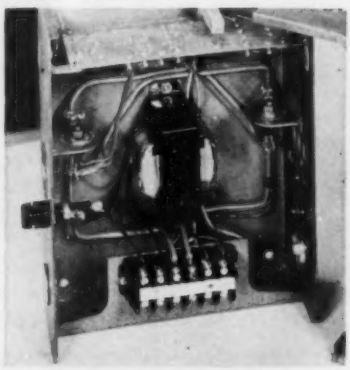


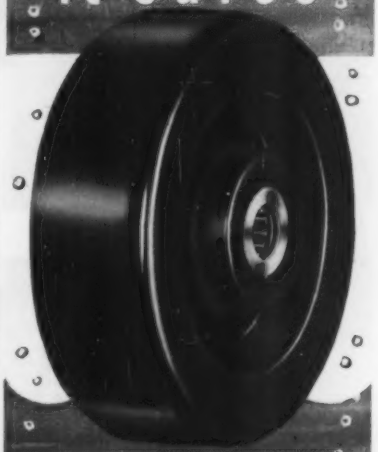
Constant-phase control . . . originally designed for electric furnaces, uses silicon control rectifiers and other semiconductor devices, taking up to 75% less space than other power control equipment. Said to have a higher power factor than conventional control devices, unit can be triggered manually or by a millivoltage control signal generated by temperature bulb, pH analyzer, dewpoint analyzer or other sensitive transducer. Provides continuous control of output over range up to 0 to 100%. Standard capacities are 15 amps, 115 v, single phase; 15 amps, 230 v, single phase. Units for larger capacities and three phase also are available. Measures 7x9x3 in. and dubbed suitable for processes requiring precise control of power output for heat generation and power control. **C I Hayes Inc, 800 Wellington Ave, Cranston, RI.**

Circle 413 on Reader Service Card

Predetermining counters . . . in both OEM and existing equipment models, register up to 1500 counts per min., or 50% faster than previous models. Electric rotary preset switches replace dials on panel-mounted model for operation at flick of switch. Reset time has been reduced to 150 millisec. Required line voltage for installation is 105 to 125 v,

continued on page 214

it's new
it wears
it saves



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WATER RESISTANT
texite wheel

Specially molded for applications requiring unusual water or chemical resistance . . plus the usual quiet, long-wearing, easy rolling-floor protective characteristics of Albion Texite Wheels.

These tough, high capacity wheels are immediately available from stock in **any** practical size from 3¼" to 16" diameters, tread widths from 1½" to 4" and capacities up to 8000 pounds. Plain, roller or sealed bearings. Price? Exactly the same as comparable models in Albion's **regular** Texite wheel line!

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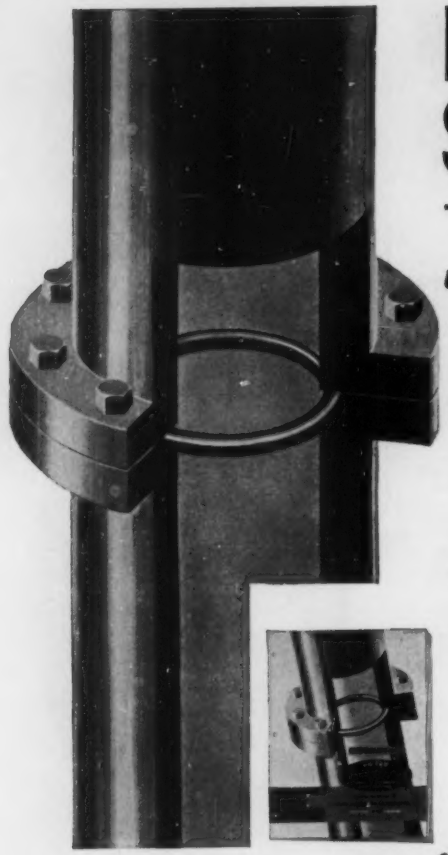

POSITIVE SEALS

−452° to 3000° F.

United Self-Energized Metallic O-Rings*...

form permanent, non-corrosive, static seals under temperature extremes from −452° to 3000° F. and pressures from 10^{-4} mm Hg to 100,000 psi. Available in various metals and coatings (including Teflon** and silver) ¼" O.D. dia. to any size and configuration. United also makes non-vented and pressure-filled O-rings. **United Metallic "O" Rings, manufactured by United Aircraft Products, Inc., Box 1035, Dayton, Ohio.**

See United Metallic O-Ring Catalog in Sweet's Product Design File or write for Free Handbook

*Patents 2,809,269; 2,837,360
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ALL AVAILABLE WITH

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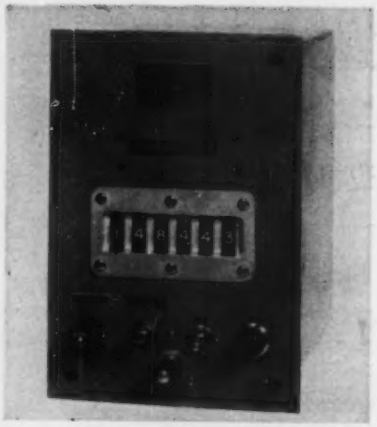

50 to 60 c. Operating fuse is 1 amp and power consumption is 6 w counting, 30 w resetting. OEM model measures 7⅜ x 4⅞ x 5½ in., weighs 5 lb, and has either 4 or 6 white-on-black decades. Suitable for control panel installation, this model has an internal terminal strip for actuator and control lead connections (also available for plug-in wiring where needed). Two existing equipment models—one with single row of preset dials and another with two rows—also are available with either 4 or 6 decades and can be dustproofed. Have electromagnetic counting units which permit use of wide variety of remote actuators. **Electronic Controls Div, Veeder-Root Inc, Danvers, Mass.**

Circle 414 on Reader Service Card

Terminal board assembly . . .

has spring-loaded diode clips to handle all types of components. Suitable for semiconductor aging racks and in making prototypes. Made of laminated silicone class cloth, it measures 2 x 13⅛ in. From stock at $458 in quantities of 100 to 249. **Cambridge Thermionic Corp, 445 Concord Ave, Cambridge 38, Mass.**

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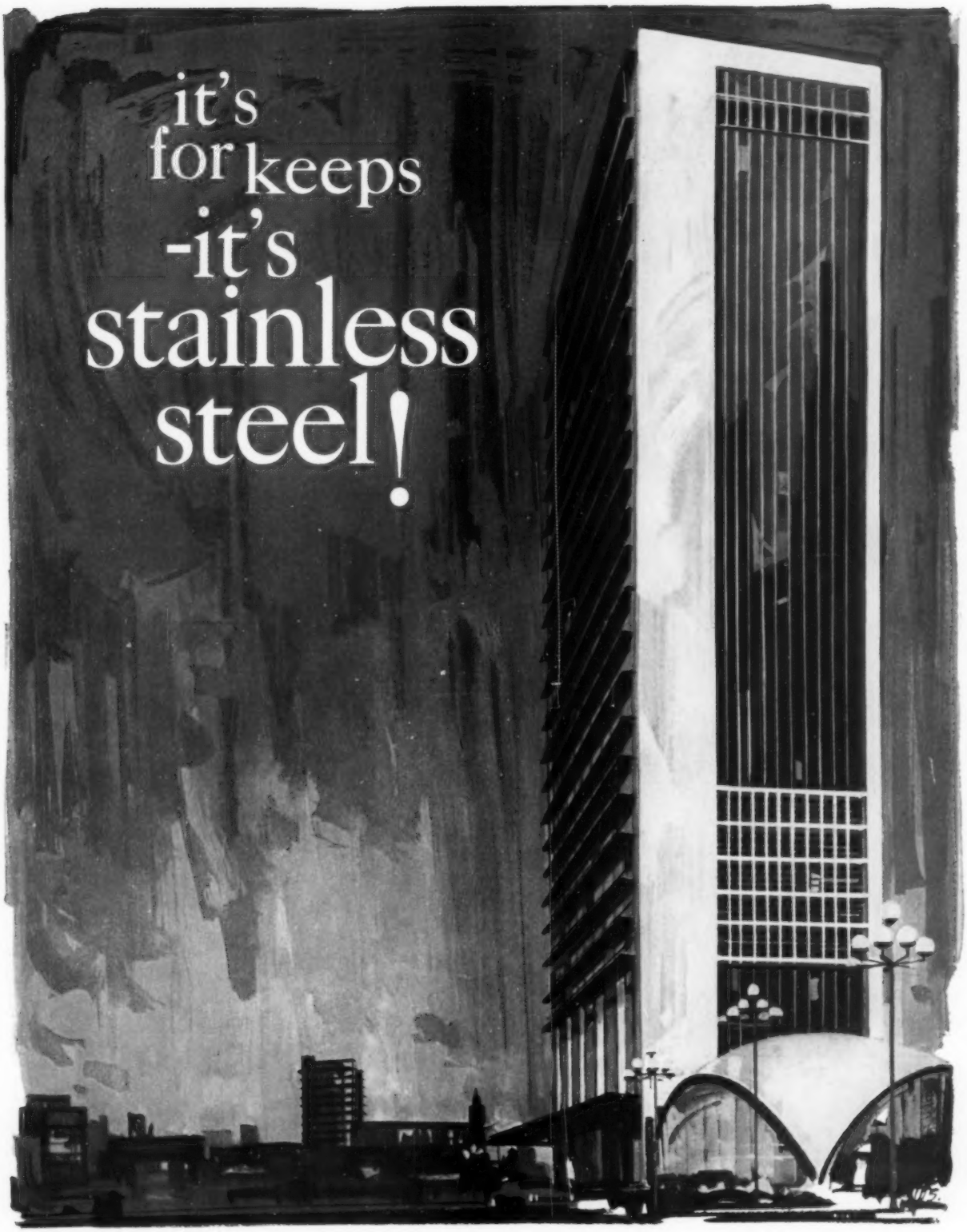
Vane pump cartridge . . .

measuring ¾ in. dia and weighing 1 oz, delivers 0.1 to 1.3 gpm at pressures from 50 to 1500 psi. Has a displacement of 0.003 to 0.013 cu in. per revolution and speed range of 8000 to 26,000 rpm. Operating life is up to 1000 hr. Suitable for circulation of fluids for cooling electronic equipment; as a low-power source for small-scale hydraulic systems; pumping fuel for under 100-hp engines; transferring liquid or gaseous fluids; and lubricating remote and/or compact mechanical system. Can be integrated with

continued on page 217



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McLouth Steel Corporation, Detroit 17, Michigan

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vibration/shock/noise control

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High-strength elastomeric mountings and joints are custom designed to control dynamic disturbances, reduce noise transmission, accommodate relative motion . . . thereby upgrading performance, reliability, acceptance. These compact, easy-to-install units resist severe conditions, often outlast metal parts, never need lubrication.

on lift trucks . . .

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mechanical and servo valves, engine fuel controls and any basic system where space is at a premium. Also can be manifolded in either series or parallel circuits. Available in various metals, plastics or ceramics. **Vickers Inc, Div of Sperry Rand Corp, Detroit 32.**

Circle 416 on Reader Service Card

Photoelectric protective unit

for machine operator safety, uses a modulated (pulsating) light beam produced by a rotating disc to detect presence of an operator's hand or arm in a high-danger area. Interruption of the beam causes a signal (produced by a projector, receiver and control relay setup) that will stop a machine. Receiving element, "tuned" to modulated-light frequency, is not influenced by ambient light in operating area. Projectors available have 1- or 2-in. light beams with ranges of up to 20 and 80 ft, respectively. **Clark Controller Co, 1146 E 152nd St, Cleveland 10.**

Circle 417 on Reader Service Card

Tri-axial accelerometer . . .

has sensitivity of 75 mv/g along its three mutually perpendicular planes. Suitable for low-level "g" studies of large turbines, ground and submerged vehicles and other heavy equipment where high signal-to-noise ratio and low frequency response are needed. Acceleration range is from 0.01 to 1000 g with max cross sensitivity of 5%. Frequency response is flat within 5% from 0.2 cps to 3 kc and resonant frequency is 20 kc. Response to acoustic noise is less 0.1 g at 155 db. Open circuit sensitivity is 90 mv/g; amplitude linearity, within 1%; and nominal capacity, 450 uuf. Temperature range is from —65 to

continued on page 218

Nicholson Welded Floats . . .

'aces' for buoyancy mediums, fluid chambers, pressure vessels

Long, trouble-free service! You can count on that, for sure, with Nicholson floats, for working pressures up to 2500 lbs. They're precision-welded to stand up to the pressure or corrosive conditions for which they're specified. Available in spherical, cylindrical or elliptical shapes . . . and from 2" to 14" diameter sizes. Float halves are die-formed, spun, laminated or electro-deposited. Walls are, therefore, uniformly thick. Annealed to avoid cracking. Butt-welded seams. *Steel Floats:* chromium, cadmium, copper plated. Also unplated, with sandblast or pickled finish. *Stainless Steel and Monel floats:* rough buffed, polished or with smooth, highly-finished welds.

This Coupon Brings You Informative Bulletin On Floats

Bulletin 753 contains facts on steel, stainless steel and monel floats, information on float connections, tables showing weight, buoyancy and collapsing pressure for spherical floats for all gauges . . . also volume and buoyancy data. Fill in and mail this coupon for your copy.

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Title_____

Company_____

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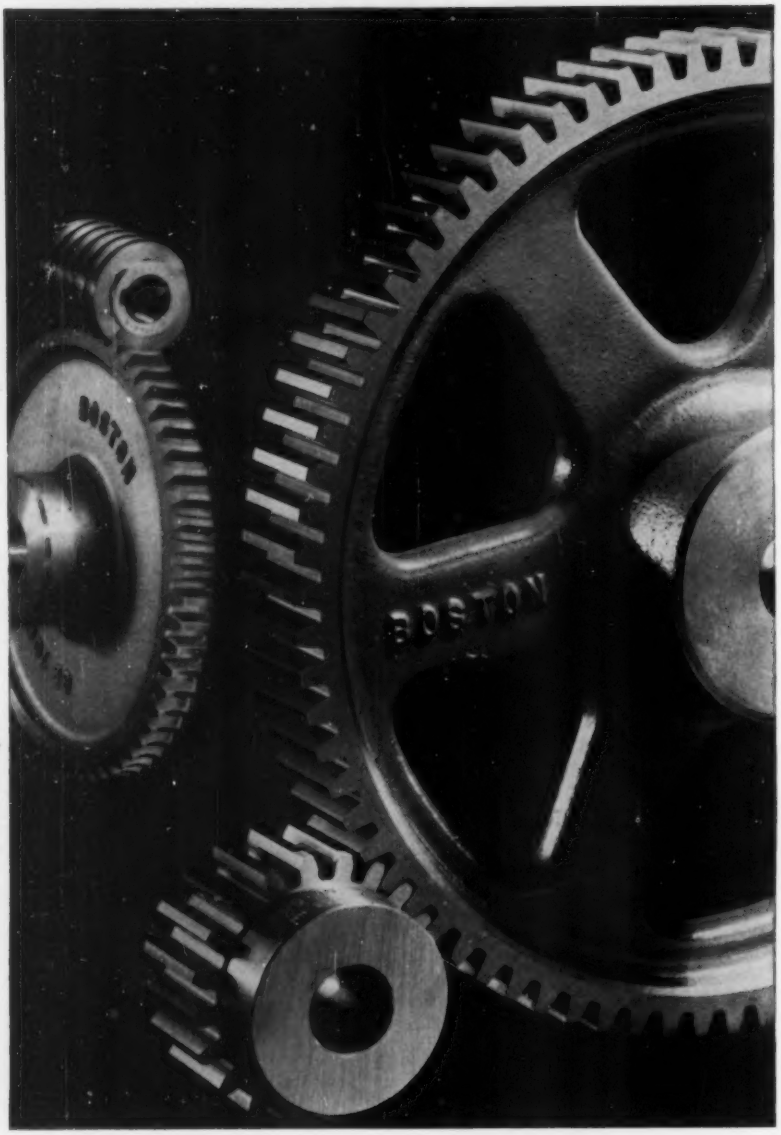
14½° stock gears 20°



Largest selection – off the shelf.

1781 types and sizes 14½° P.A. – 48 to 3 pitch.

782 types and sizes 20° P.A. – 120 to 4 pitch.

Spur, bevel, miter, worm, helical, spiral miter.

Brass, steel, iron, nonmetallic. See Catalog 57.

IN STOCK at your nearby DISTRIBUTOR

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Quincy 71, Mass.

300 F (hi-temp units go up to 500 F). Measures 1.56 x 1.44 x 1 in. and weighs 125 grams. Delivery in 2 wk at $435 each for 1 to 5 units; $391 each for 6 to 10 units; and $369 each in quantities of 11 to 50. **Columbia Research Laboratories, MacDade Blvd and Bullens Lane, Woodlyn, Penna.**

Circle 418 on Reader Service Card

Miniature thermostat . . .

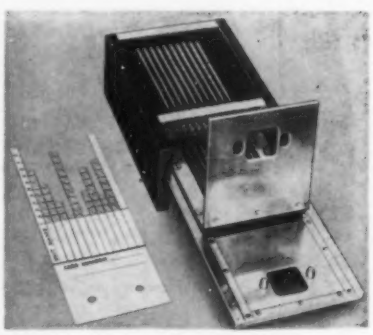
incorporating a bimetal actuated contact, is insulated by two glass seal solder terminals. Can be calibrated and hermetically sealed at factory or by user. Max differential is ½° C. **Chatham Controls Corp, 159 River Rd, Chatham, NJ.**

Circle 419 on Reader Service Card

Inertia switch . . .

is a SPDT, unidirectional switch with a range of 2 to 30 g ±5%. Response time is 0.015 sec; electrical rating, 2 amp at 28 v dc; and temperature range, —65 to 250 F. Automatically resets itself when applied acceleration is removed. **Inertia Switch Inc, 311 W 43rd St, New York 36.**

Circle 420 on Reader Service Card



Card-based sensing system . . .

comprises a reader and vinyl cards that are cut with a scissors into a series of "fingers" (up to 40 will be available), with each length in direct proportion to its command signal. When a card is inserted in the reader, "fingers" determine position of pickoffs on a series of linear potentiometers mounted on ¼-in. centers. Direct reading eliminates need for relays or stepping switches to translate coded information from punch cards. Pickoffs are returned to "zero" when card is removed. System is said to be capable of more than 1 million readings with repeat accuracies of better than one part in 1000. Readings of two or more fingers

continued on page 219

can be cascaded in "coarse-fine" control systems to provide accuracies of one part in 30,000 or better. **Jordan Controls Inc, 3235 W Hampton Ave, Milwaukee 9.**

Circle 421 on Reader Service Card

Metal spinning process . . .

produces high-tensile-strength materials in large diameters, thicknesses; reportedly spins thicknesses heavy as ½ in. and accomodates disk diameters up to 170 in. from such hard-to-form materials as Vasco Jet 1000, D6A, Air Steel X-200 Potomac A, H-11, Unimach 1 & 2, etc. After heat treating and spinning, ultimate strengths of some tool steels are said to have ranged from 280,000 to 300,000 psi at room temperatures. Variety of configurations reportedly can be produced. **Phoenixspun Div, Phoenix Products Co, 4711 N 27th St, Milwaukee.**

Circle 422 on Reader Service Card

Adjustable power resistor . . .

has its resistance element wiped at 2 points, slider at 8 points. This redundancy of all contact points, plus dual solder lugs, is said to improve reliability. Floating construction allows mounting on uneven surfaces and eliminates damage or adjustment change due to thermal expansion and shrinkage. Requiring only ½ cu in. of packaging space, unit can be stack-mounted with 4-40 screws or chassis-mounted, using a single ⅜-in. volume-control hole. Operating temperature range is from —94 to over 392 F, and use of precision-potentiometer wire is said to give unit "unusually stable" resistance through broad temperature range. Nominal power rating is 10 w in still air at 77 F to 20 w with forced air cooling. Normal temperature coefficients are reportedly as low as those of precision resistors. Available with resistances from 25 to 100,000 ohms, unit is said to last for 2000 hrs at 482 F and indefinitely at 302 F. Adjustment range is 95% of total resistance with 36 full turns. Dielectric strength is 1500 v dc; resolution, 0.7 to 0.07%, depending on resistance. **Invar Electronics Corp, 1723 Cloverfield Blvd, Santa Monica, Calif.**

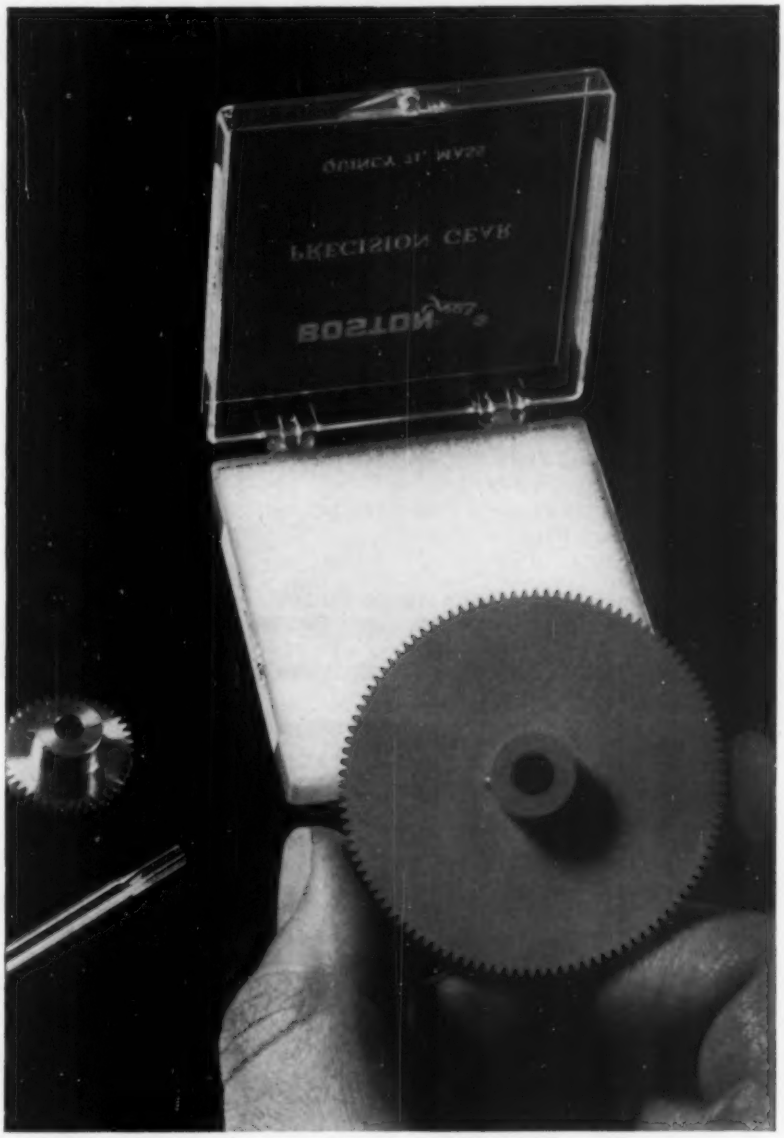
Circle 423 on Reader Service Card

5-hp electronic drives . . .

are for 440-v, 60-c operation and are supplied with 2400-rpm base speed motor with speed range of from 60 to 2400 rpm. Torque rating is base speed torque throughout entire speed range, and speed

continued on page 221

BOSTON Gear® certified
precision spur gears



Stainless Steel 10 to 40 teeth Aluminum 42 to 180 teeth

Certified AGMA Precision Class 1 or better.
Standard sizes from local Distributors' stocks
120 to 48 pitch – 20° P.A. Get new Catalog PG160
Conform to Military specifications
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CIRCLE 219 ON READER SERVICE CARD 219

"Dyflon"®

Self-Aligning and Self-Lubricating SPHERICAL BEARINGS

Combine "Monoball"® Engineering Advantages with Life-Time Lubrication

Design engineers in many industries are specifying new "DYFLON"® SELF-ALIGNING and SELF-LUBRICATING SPHERICAL BEARINGS for these 5 major reasons:

1. **LOWER COEFFICIENT OF FRICTION** ...ideal where lubrication is impossible or undesirable.
2. **WITHSTAND EXTREME VIBRATION** ...perfect performance under shock load conditions.
3. **WILL NOT "COLD-FLOW"** ...even under extreme load conditions.
4. **IMPERVIOUS TO KNOWN CHEMICAL SOLVENTS** ...eliminates corrosion problems.
5. **FAIL-SAFE** ...due to "Monoball"® design.

Request Engineering manual No. 551.

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Available in a variety of plain or rod end types. Bore sizes to 3.000". Materials include stainless steel, plastic alloys and chrome alloy steels. Ultimate static loads to 500,000 lbs.

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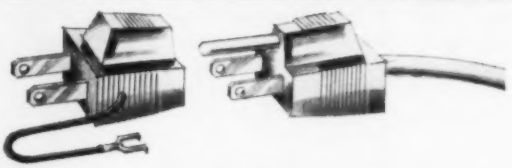
220 CIRCLE 220 ON READER SERVICE CARD



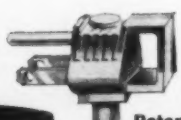
An attractive answer to grounding requirements

THREE-WIRE CORD SETS are now required by many codes, but you can meet them without sacrificing product sales appeal.

Miller Electric 3-prong plugs, matching adapters and job-rated strain reliefs molded on vinyl insulated wire co-ordinate your product's color and style to make it more functional, more attractive.

It costs no more to select from the industry's largest line of **stock** components, or to have Miller's complete, cost-conscious engineering service design custom components for your products.

See Miller at
DESIGN ENGINEERING SHOW
Booth 300-302



MILLER ELECTRIC CO.
120 Main St., Pawtucket, Rhode Island

Patented FINGER PULL style available

CIRCLE 274 ON READER SERVICE CARD

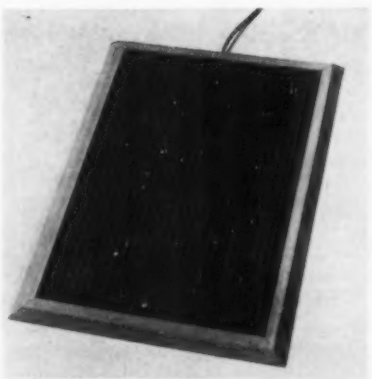
regulation is within 2% of set speed over that range from no load to full load. Available for either uni-directional or bi-directional operation. **Electro-Devices Inc, PO Box 2308, Paterson 23, NJ.**

Circle 424 on Reader Service Card

Chassis slide . . .

supports loads up to 75 lb per pair and requires only ½-in. horizontal side space and less than 2 in. in vertical side space. Can be made to lock in fully extended position. **Grant Pulley & Hardware Corp, High St, West Nyack, NY.**

Circle 425 on Reader Service Card



Heavy-duty switching carpet

has sealed flat switch elements between rigid fibrous sheets. Carpet, ½-in. thick and finished with molded "ramped" edging, is suitable for machine safety, door controls and signals and alarms. Can be supplied in odd shapes and sizes and with choice of surfacing and colors. Since unit is fabricated, surface material can be anything from conventional ribbed rubber to deep pile carpeting, tile or battleship linoleum. **Tapeswitch Corp of America, 229-24 Linden Blvd, Cambria Heights 11, NY.**

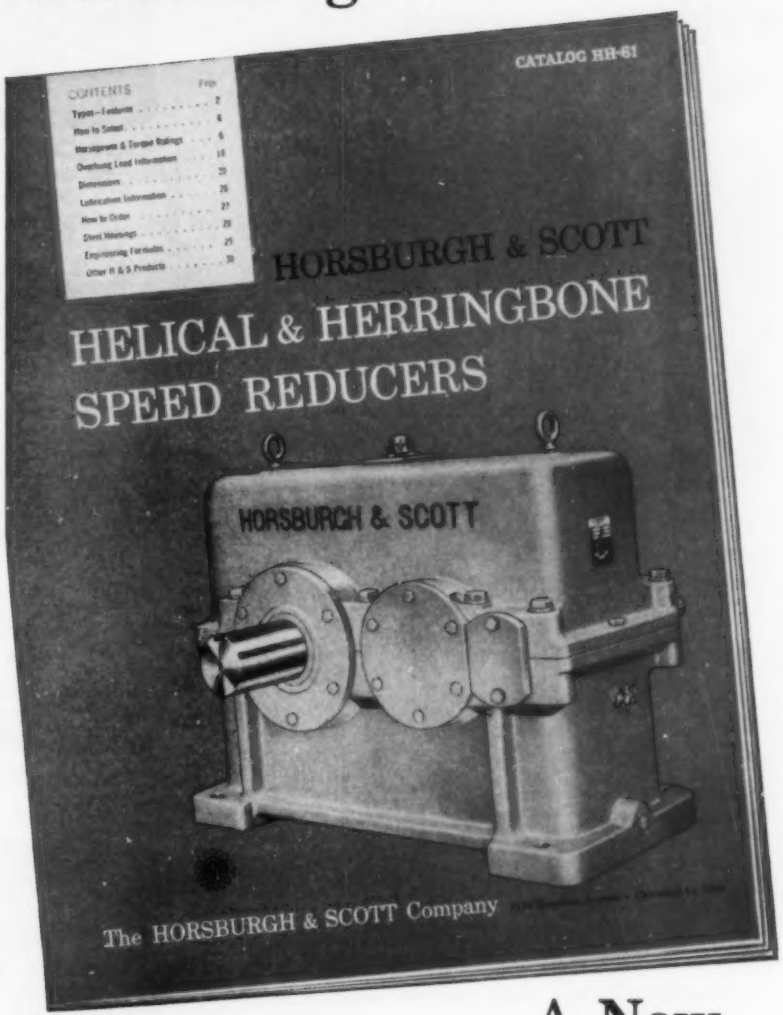
Circle 426 on Reader Service Card

Core-transistor logic element

can perform following functions up to 250 kc: OR, INHIBIT, BRANCH, AND, TRANSFER, DRIVE, COUNT, COMPLEMENT. Available with either positive or negative input/output pulse polarity, the magnetic dynamic digital logic element requires a single 12-v power supply. Min one to zero ratio is 15:1 and power requirements for 100% duty are 100 milliw; for standby, 25 microw. Standard unit operates to 149 F at 100% duty cycle (military versions are obtain-

continued on page 223

Introducing . . .



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Let our engineering staff give you prompt assistance with your enclosed gearing requirements.

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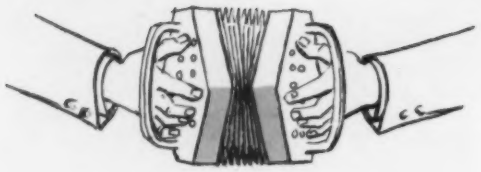
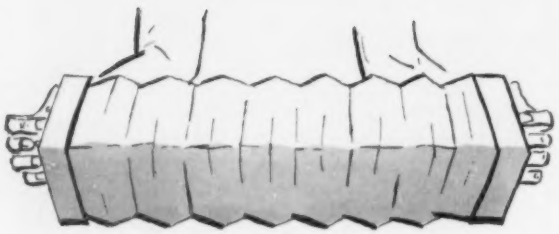


USE AIR PRESSURE—



—OR VACUUM

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TO SOLVE NEW PROBLEMS

—these Bulletins may help you find low-cost solutions

For dependable functioning of products or equipment you build, *use pneumatics!* Often, air "works wonders" unmatched by other methods. It's a versatile, controllable, economical medium of force and power through vacuum and pressure.

For example:

Gast Rotary Air Motors (to 7 h.p.) deliver reversible, variable-speed, explosion-proof power. They're compact — weigh less — cost less.

Gast Compressors (to 30 p.s.i.) supply air blast or pressure to lift, push, mix, atomize, oxidize, pressurize on many jobs.

Gast Vacuum Pumps (to 28" Hg) are used to hold, lift, position and shape parts — to test, control, fill, evacuate — in 101 ways.

Use pneumatics—"Air may be your Answer!"

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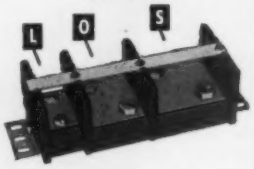
GAST MANUFACTURING CORP.

P.O. BOX 117-V BENTON HARBOR, MICHIGAN

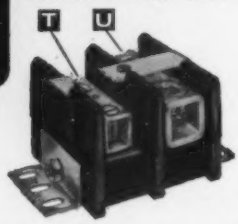
NEW, IMPROVED!
CURTIS
High Current Terminal Blocks

Types "L", "O" and "S"
for Wires or Cables with lugs.



- Nickel plated copper terminal bars for good conductivity.
- Type "L"—750 Volts 100 Amp. Capacity, for up to AWG No. 1 wire—1 to 12 terminals.
- Type "O"—750 Volts 125 Amp. Capacity, for up to AWG 1/0 wire—1 to 4 terminals.
- Type "S"—750 Volts 225 Amp. Capacity, for up to AWG 4/0 wire—1 to 4 terminals.
- White Fibre Marking Strips.

Types "T" and "U"
With High Pressure Solderless Connectors



- 750 Volt 125 Amp. and 250 Amp. Capacity.
- 100% pure electrolytic copper tubular connectors provide 100% conductivity.
- Wire clamping screws give positive and completely positioned connection.
- No expensive lugs—no lug assembly time required.
- Type "T" for AWG #6 to 1/0 wire, 1 to 6 terminals.
- Type "U" for AWG #4 to 250 MCM wire, 1 to 4 terminals.
- White Fibre Marking Strips.

Write for Bulletins DS-128 and DS-129 for Complete Details

CURTIS DEVELOPMENT & MFG. CO.

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CIRCLE TEMPLATE

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ONE OF MORE THAN 30 RAPIDESIGN TIME-SAVER TEMPLATES — ALL OF WHICH ARE BETTER MADE, MORE USEFUL AND LESSER PRICED.

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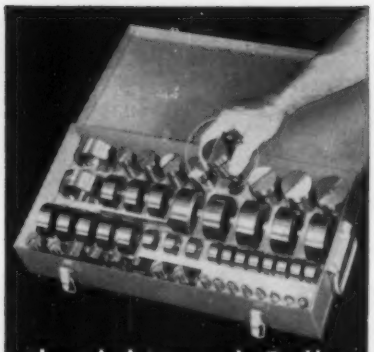
CIRCLE 222 ON READER SERVICE CARD

CIRCLE 276 ON READER SERVICE CARD



the right punch & die at your finger tips...

NEW DI-ACRO PUNCH PAKS

Punch Pak No. 1 - $139.50
Punch Pak No. 2 - $259.50

- **Off the shelf delivery**
- **Adapters to fit any punch press**

Di-Acro Punch-Paks save you money, cut production delays. No time lost looking for the right size or waiting for special orders. Cost is approximately 10 per cent less than individual punch and die sets—with the rugged, steel store-or-carry chest free. All Di-Acro Punches and Dies are precision made of quality tool steel.

PUNCH-PAK NO. 1 contains 30 sizes of round punches and dies from 3/64″ to ½″ in increments of 1/64″.

PUNCH-PAK NO. 2 contains round punches and dies from 1/16 to ½″ in 1/16″ increments, round sizes from ½″ to 2″ in ⅛″ increments, squares in ½″, 5/8″, ¾″ and 1″ sizes, one die holder and two die adapters.

Die Adapter A-2 ¾″ diameter—1¼″ bore, Die Adapter B-2 ¾″ diameter—2⅛″ bore.

DIMENSION DATA

All Di-Acro Punches to ½″ have ½″ diameter shanks, 2 13/32″ length.
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All Di-Acro Dies to ¾″ are 1¼″ diameter, ⅝″ high.
All Di-Acro Dies from ¾″ to 1⅜″ are 2⅛″ diameter, ⅞″ high.
All Di-Acro Dies from 1½″ to 2″ are 2¾″ diameter, 15/32″ high.

PUNCH AND DIE HOLDERS

which adapt Di-Acro Punches and Dies to any punch press are listed in literature on single station punch and die program. Ask for it . . . also for literature on new Adjustable Punch and Die program.

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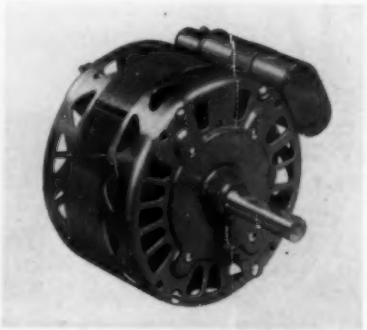
able for operating temperatures to 257 F). Humidity range is 0 to 95% RH and altitude range is unlimited. Military versions are available at about 45% of standard size, which is ⅝ x ⅝ x ⅞ in. Priced in small quantities at $24 each. Delivery in 2 to 4 wk. **Di-An Controls Inc**, 944 Dorchester Ave, Boston 25.

Circle 427 on Reader Service Card

Motor-pump units . . .

are available in eight combinations, using four pump sizes and five fractional-hp motors from 1/20 hp at 1750 rpm to ¼ hp at 3600 rpm. Capacities range from 6 gph at 40 psi on smallest unit to 360 gph at 10 psi on largest unit. Operating on "progressing cavity" principle (cavities formed between rotor and stator when former turns within latter move toward discharge port in the manner of a precision screw conveyor), units can pump abrasive slurries and solids in suspension, as well as water-like liquids. **Moyno Pump Div, Robbins & Myers Inc**, Springfield, Ohio.

Circle 428 on Reader Service Card



Permanent split capacitor motor . . .

measuring 4⅞ in. dia, is available in both 4- and 6-pole design, from 1/20 to ¼ hp. Has low current requirements, resulting in less heat rise for a cooler running unit. Also said to combine higher starting torques with increased efficiency. **Redmond Co Inc**, Owosso, Mich.

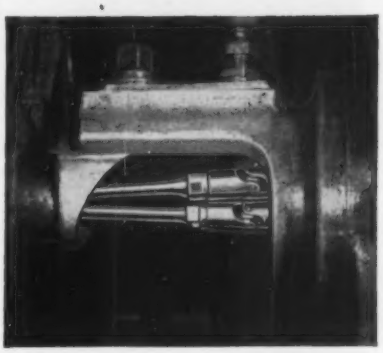
Circle 429 on Reader Service Card

Ac and dc latch-in relay . . .

comprises two Class 88 relays with interlocking latch-in levers mounted on a common base. When armature of one relay is energized and pulled in, it is latched by the interlocking levers while other armature releases and drops out. Except

continued on page 225

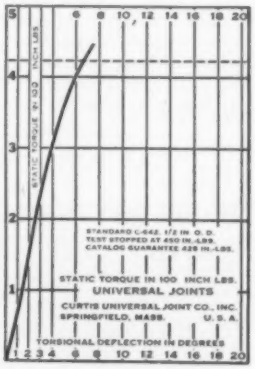
Solving a breakage problem AT CLOSE QUARTERS



The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint.

THE SOLUTION was a Curtis Universal Joint of the same size.

Torque Curve ½" Curtis Universal Joint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STANDARD C-642, 1/2 IN. O. D.
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CURTIS UNIVERSAL JOINT CO., INC.
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TORSIONAL DEFLECTION IN DEGREES

This is only one of many problems solved by Curtis Joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and over 30 years' experience manufacturing universal joints make them that way.

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⅜" to 4" O.D. (6" joints on special order)

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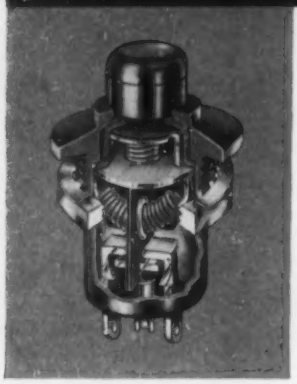
ELECTROMECHANICAL COMPONENTS

PRECISION MADE FOR MAXIMUM RELIABILITY



SNAP SWITCHES per MS-25089

Sinusoidal, toggle spring design ensures positive, tease-proof snap action... minimum arcing and contact wear. Heavy coin silver contacts for long life and low resistance. Color coded buttons. Wide choice of housings, mountings and contact arrangements.

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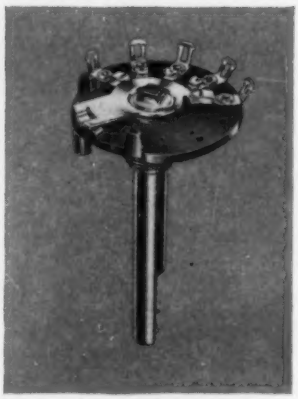
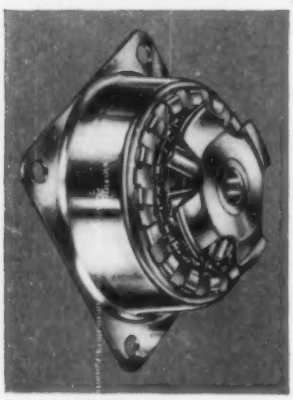
LOW-COST PK ROTARY SWITCHES

Cycle Life: 100,000 cycles minimum. Light, strong, molded nylon with silver-plated brass or solid silver alloy contacts and rotor blades. Available in black or special colors.



FOR FULL ENGINEERING DETAILS, CIRCLE INQUIRY CARD NO. 251



EQUIFLEX all metal VIBRATION ISOLATORS

Outperform rubber (absorb shock from all directions) outlast rubber (unaffected by dirt, grit, oils, corrosive atmospheres). Available in plate and cup types for loads up to 35 lbs. per mount.

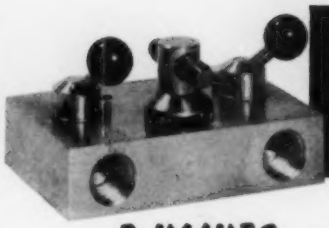
FOR FULL ENGINEERING DETAILS, CIRCLE INQUIRY CARD NO. 252

BOOTH NUMBER 1240
DESIGN ENGINEERING SHOW

DOT

The UCINITE COMPANY

Division of United-Carr Fastener Corp.
Newtonville 60, Mass.



CIRCLE SEAL MANIFOLD VALVE...

3 VALVES IN ONE ...COMPACT ...LEAKPROOF

Completely positive sealing to 2000 psi.
Reduces installation costs.
Available in brass or 303 stainless.

Specifically designed for use with differential type measuring, recording or transmitting instruments in refinery, petrochemical plants, pilot plants, test labs and research labs.

Complete absence of cross port leakage provides reliable, accurate instrument readings. Because of the three valves designed into one compact body... two tees, four nipples and eight threaded connections are entirely eliminated with resultant cost savings.

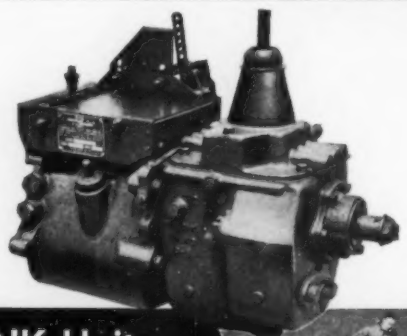
The P-727 does not require valve seat replacements and no operating adjustments are necessary.

One variation provides a bleed hole to vent both instrument ports when balancing valve is open. Another variation replaces basic five valve assembly.

CIRCLE SEAL PRODUCTS CO., INC.
2181 East Foothill Blvd.,
Pasadena, Calif.

CIRCLE SEAL
precision valves

CIRCLE 278 ON READER SERVICE CARD



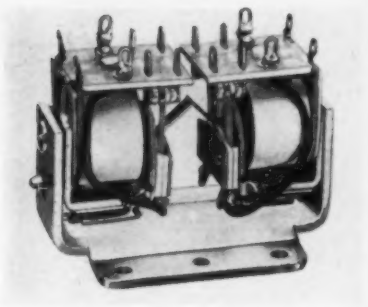
FUNK Units give this tractor *EXTRA* performance!

Smooth, instant power shifting — both forward and reverse — with just one lever!
And this FUNK Revers-O-Matic® Drive installation provides neutral speed control for Napco, leaves driver's hands free for other operations.
Just one example of how FUNK MODULAR POWER UNITS may be combined — in an unlimited number of arrangements — without special engineering costs.

Let FUNK solve your power transmission problem.

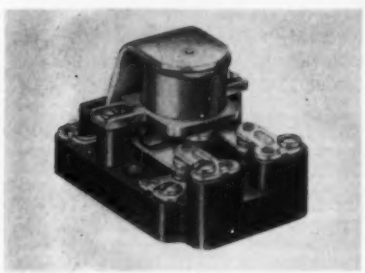
FUNK MFG. CO. Box 577-D, Coffeyville, Kansas

CIRCLE 224 ON READER SERVICE CARD



for latch-in levers, each relay is and independent and can have completely different contact arrangements and operating coils. Complete unit measures 2 1/8 x 1 3/4 x 1 11/16 in. From stock are 4PDT and 6PDT contact combinations with 10-amp contacts for 6, 24 and 115 v ac and dc. Prices range from $9.50 to $13.50 for quantities of 1 to 9. **Magnecraft Electrict Co, 3350Y W Grand Ave, Chicago 51.**

Circle 430 on Reader Service Card

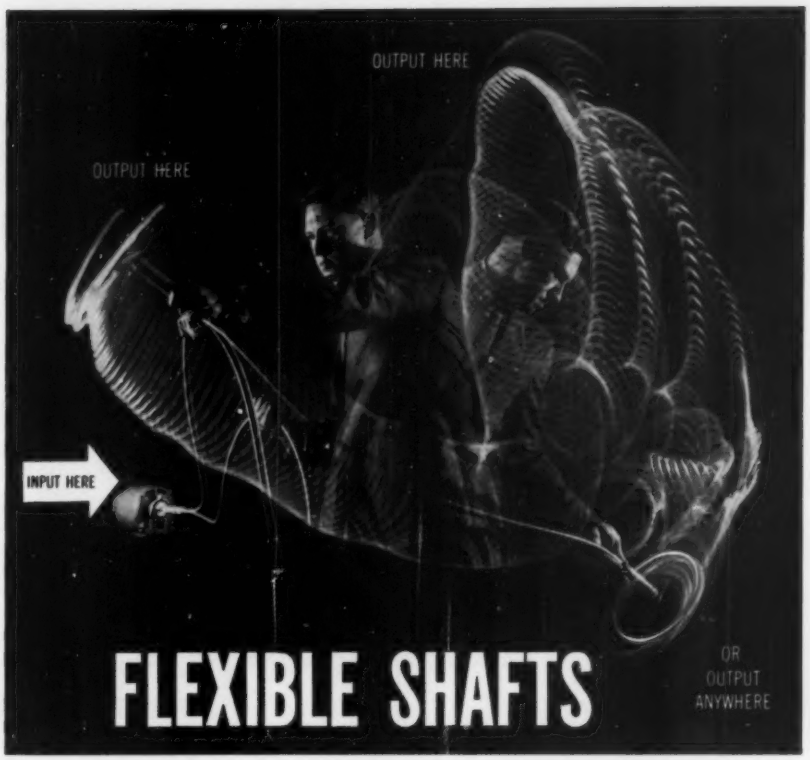


Power relay . . .
has inverted coil which protects armature and contacts from electrical and physical malfunctions. Measures 3 7/16 x 2 1/2 x 2 1/8 and weighs 8 oz but is said to surpass larger units in electrical load. DPDT contacts are UL rated for 15 amps at 115 v ac noninductive, or 1 hp at 115/230 v, 60 c. Available in voltages of 6, 12, 24, 115 and 230 v ac and 6, 12, 24, 110 and 220 v dc. Equipped with recessed auxiliary switch. **Guardian Electric Mfg. Co, 1550 W Carroll Ave, Chicago 7.**

Circle 431 on Reader Service Card

Four-digit angle counter . . .
originally designed as navigational instrument in aircraft panels, is said to weigh more than 50% less (approx 1.12 oz) than standard angle counters with same basic counting configuration. Measures less than 3/4 in. high x 1 in. deep and provides readings from 000.0° to 359.9° with characters a full 1/8 in. tall. Numerals are engraved on dull black counter wheels

continued on page 227



put power where you want it

Flexible shafts give the designer important new freedom in transmitting rotary power or control between two points. They enable you to position your power source and your driven part to best advantage . . . without worrying about obstructions, vibration, shock or alignment.

Even if the components are in relative motion to each other, you can still transmit power smoothly and economically.

Flexible shafts also reduce manufacturing costs . . . use fewer parts . . . eliminate cumbersome gears, drives, couplings, universals. With rigid connections gone, alignment and tolerance problems fade away, and installation is a snap.

Whatever your rotary transmission problem, there is a good chance that one of S. S. White's flexible shaft lines can solve it . . . *Standard, Pre-Engineered,* or *Custom-Designed* flexible shafts.

S. S. WHITE INDUSTRIAL DIVISION,
DEPT. 14 10 East 40th Street, N. Y. 17, N. Y.

BOOTH 916 DESIGN ENGINEERING SHOW

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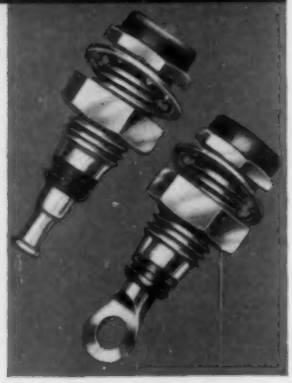
IN FLEXIBLE SHAFTS

CIRCLE 225 ON READER SERVICE CARD

ELECTROMECHANICAL COMPONENTS

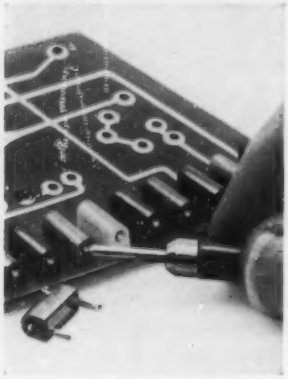
PRECISION MADE FOR MAXIMUM RELIABILITY

TEST JACKS per MS-16108



Heat-treated Berylco contacts, silver-plated. Color-coded nylon insulators. Available with turret, spade, taper pin, slotted or feed-thru terminals . . . standard, back-mounting or limited-space mounting shells.

FOR FULL ENGINEERING DETAILS, CIRCLE INQUIRY CARD NO. 247

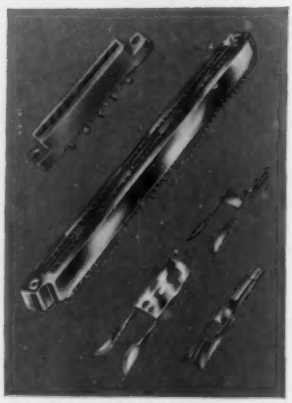


LOW COST printed circuit TEST JACKS

Gold-over-silver-plated Berylco contacts per MIL-F-14072, M-310. Nylon bodies in 11 standard code colors. Simplified construction affords economical use in all quantities. Immediate delivery from stock.

FOR FULL ENGINEERING DETAILS, CIRCLE INQUIRY CARD NO. 248

TORSION CONTACT printed circuit CONNECTORS



Rolled contact points (see separate illustrations at right) ensure high pressure, clean connection without scoring . . . allows .020" variation in card thickness without setting contacts. Polarizing keys available.

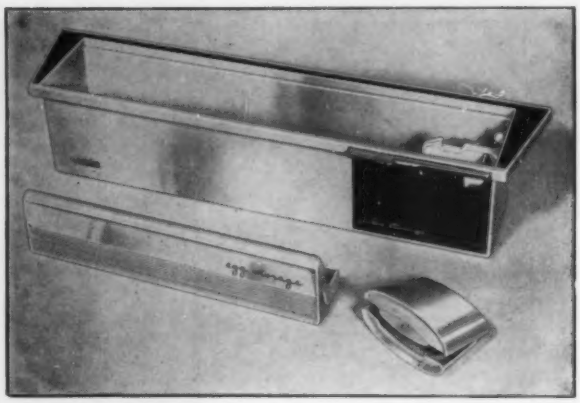
FOR FULL ENGINEERING DETAILS, CIRCLE INQUIRY CARD NO. 249

BOOTH NUMBER 1240
DESIGN ENGINEERING SHOW

DOT

The UCINITE COMPANY

Division of United-Carr Fastener Corp.
Newtonville 60, Mass.



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- Minimum Contact with Materials
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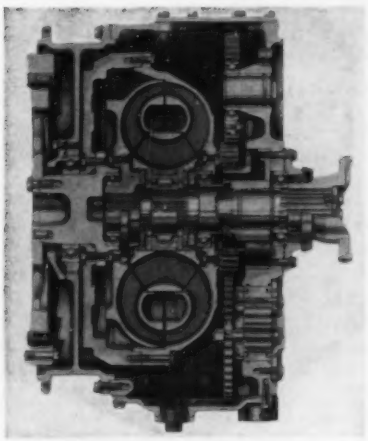
- Straight Runs or Turns
- Special Alloys for Higher Temperatures

WIRE BELT COMPANY OF AMERICA

10 RIVER STREET, WINCHESTER, MASSACHUSETTS
CIRCLE 226 ON READER SERVICE CARD

and are filed with bright flat-white pigment. Each numeral on the "tenths" counter wheel provides increasing or decreasing readings of 1/10 of a deg, but a vernier scale on right edge of wheel permits reading in increments of 3 min. One revolution of the input shaft provides one revolution of the "tenths" wheel and 1 deg of angular change. Can be operated continuously in either direction at 200 rpm. **Bowmar Instrument Corp, 8000 Bluffton Rd, Fort Wayne, Ind.**

Circle 432 on Reader Service Card

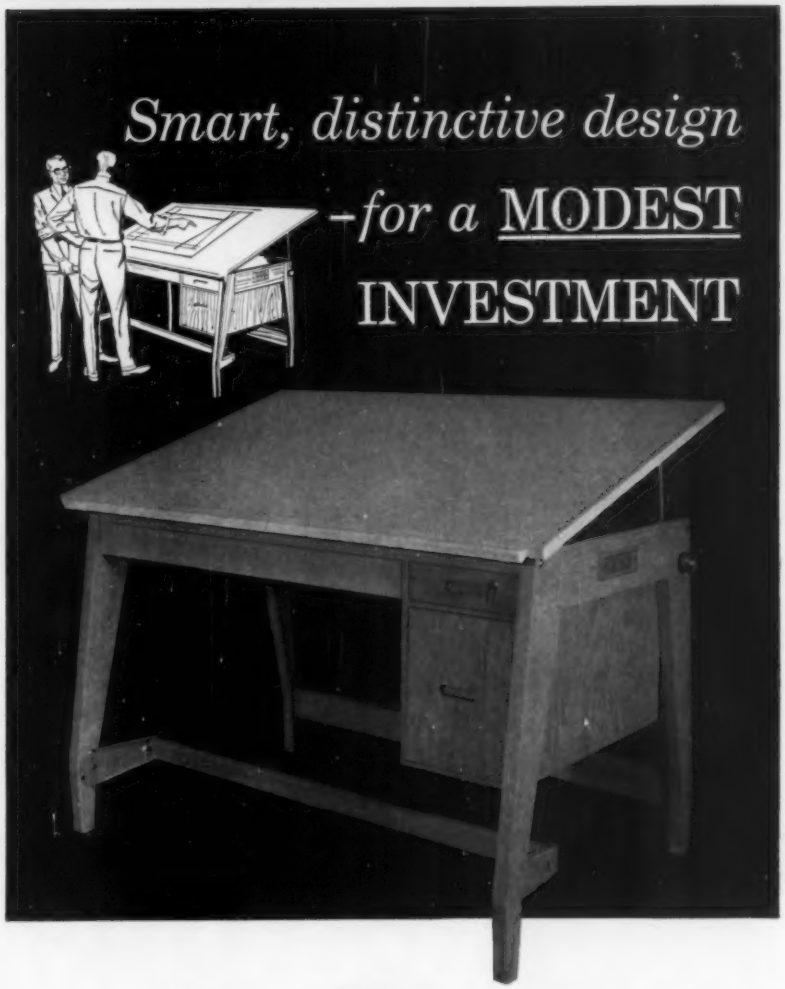


Torque converters . . . provide an infinite number of torque-speed ratios for off-highway vehicles, wheel and track-laying tractors, stationary power units, industrial drives, etc. Handling loads from 100 to 700 hp, units have torque multiplication ratios from 2.3:1 to 3.5:1. Sizes range up to 18⅜ in. dia. Described as single stage, three-element types they come with or without automatic over-running reaction members for fluid coupling operation. All sizes are said to attain high efficiency combined with high stall torque ratio. Smooth fluid velocity within converters is maintained through reduced turbulence. Self-contained internal hydraulic thrust forces are taken across two heavy-duty roller thrust bearings. This allows ball bearings to become purely radial supports, thus lengthening converter life. Drive can be direct spline to flywheel or flexible rubber drive coupling. **Rockford Clutch Div, Borg-Warner Corp, Rockford, Ill.**

Circle 433 on Reader Service Card

Tiny wire-wound resistor . . . for microminiature circuts, measures ⅛ x ⅛ in., or 1/64 the size of smallest military

continued on page 229



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CL 100 SERIES

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A HOST OF NEW FEATURES including: *new canted leg styling* which assures traditional Hamilton stability without side cross rails; new attractive finish; light Sahara Tan for smart, modern beauty. *Fully adjustable footrest:* may be set in any of five positions for comfort. *Steel reference tool and catalog drawers:* easy operation with wood fronts for harmonious design. Choice of 31″ or 37″ heights. Write today for full information on this unique, low-cost utility drafting table.

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new dimensions in time and space efficiency for: physicians; dentists; industrial, hospital, school laboratories; draftsmen; printers; libraries; home laundries.

Hamilton Manufacturing Company, Two Rivers, Wisconsin

CIRCLE 227 ON READER SERVICE CARD

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If you're looking for prototype precision in quantity production with immediate delivery schedules, you just can't beat DYNACO Precision Stock Gears and Assemblies engineered to answer every conceivable transmission requirement.

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CIRCLE 280 ON READER SERVICE CARD

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Insulate and Fasten without bushings, washers, etc. In Stock 2-56, 4-40, 6-32, 8-32, 10-32 and ¼-20.

See US AT BOOTH 100—Design Engineering Show—Detroit

Black Nylon **"NyGrip" cable clips**

Light-weight non-conducting support for wiring, tubing, etc. In Stock 1/16" to 1½" Dia.

Free samples • write **WECKESSER CO.**

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protect instruments from line pulsations and surges on refrigeration and automotive systems...

CHEMIQUIP'S NEW RS SNUBBERS

Designed for automotive, refrigeration or air conditioning applications, Chemiquip's newest snubber assures steady, accurate pressure readings . . . smooths out pressure impulses and fluctuations . . . protects pressure-sensitive instruments. Snubber element fabricated of Type 316 porous stainless steel membrane; unaffected by suspended oils in freon-type refrigerants . . . does not clog or plug.

Available in brass or steel in ⅛" and ¼" npt, male or female by ⅛", ¼", 5/16" and ⅜" flared and compression tubing.

Write TODAY for detailed bulletin B-55

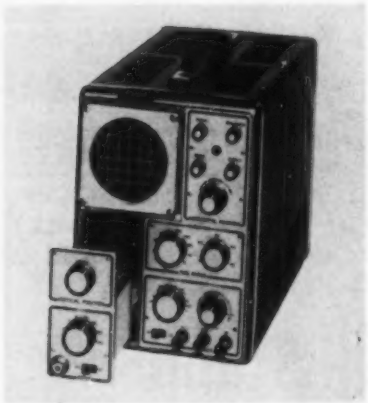
CHEMIQUIP CO. 36 East 10th St., New York 3 GRamercy 7-3772

CIRCLE 228 ON READER SERVICE CARD

CIRCLE 281 ON READER SERVICE CARD

type resistor. Available in resistive values from 1 ohm to 50 k and with power rating of 0.02 w. Uses no bobbin or heavy electrical leads as found in conventional wire-wound resistors. Wire as small as 0.0045 in. in dia is wound on a spindle until correct number of turns have been completed for desired resistance value. An epoxy bonding agent then is applied to the coiled wire, and the wire ends are attached to appropriate circuit terminals. Unit also can be secured directly to a printed wiring board with suitable bonding agent, making it an integral part of the board. **Neon Resistor Corp, 155 Saw Mill River Rd, Yonkers, NY.**

Circle 434 on Reader Service Card



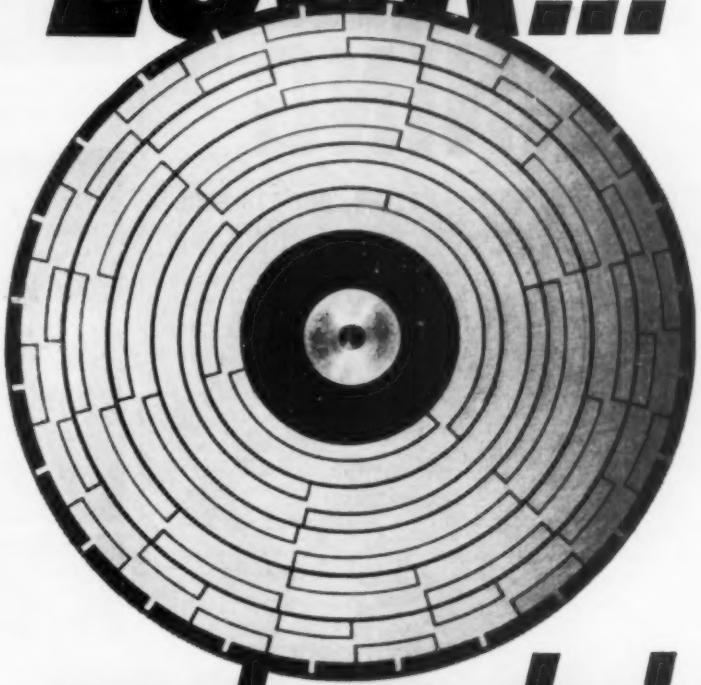
Portable oscilloscope . . . weighing 20 lb, has a time and voltage measurement accuracy of 5%. Bandwidth is from dc to 7.5 mc/s, and high-gain, plug-in amplifier provides sensitivity of 1 milliv per cm with reduced bandwidth. Calibration on both axes can be checked against a self-contained 1% calibration circuit, and sweep is continuously variable from 1 microsec/cm to 1.5 sec/cm. Priced at $395. **Interlab Inc, 116 Kraft Ave, Bronxville, NY.**

Circle 435 on Reader Service Card

Oil level gages . . . in 4-, 6- and 8-in. long sight openings, are direct reading units for hydraulic and lubricating oil reservoirs and for such other liquid level applications as diesel fuel and kerosene tank, oil crank cases, gear and chain cases, etc. Through use of interchangeable parts, gages can be furnished with components compatible with petroleum products, fire-resistant fluids, etc. Require no machining, welding, extra parts or extensive assembly labor to install and have min of protrusion with

continued on page 231

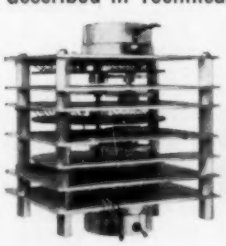
LOOK...



no hands!

This printed circuit disc is the "face" of a clock that tells time in digital code

. . . or any code your computer, control system, or data processing device needs to keep it properly in touch with the world of real time.—A. W. Haydon is a company of infinite variation when it comes to such analog-to-digital converters, or "binary encoders". Time periods range from seconds to weeks. Sizes range from miniature to large. They come sealed, enclosed or open, with AC, DC, or pulse drive, and with an imposing variety of accessory equipment.—The model shown is for commerical use. It provides a discrete signal for each two-minute interval over a 28-day period. It is used, among other places, in an automatic parking lot ticket computing system.—This and several other time code generators are described in Technical Brochure SP9-2. It's yours for the asking. Similar solid-state devices can be supplied by our Culver City, Calif., facility.



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can help you solve design, performance and cost problems because it offers you

ANY SHAPE from simple rectangular blocks to intricate, curved segments.

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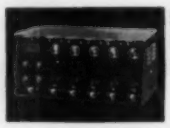
Industrial and Automotive Brake Blocks and Linings • Transmission Linings • Special Clutch Facings • Vibration Controls • Sheet Packing

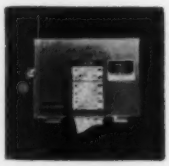
BEST TODAY — STILL BETTER TOMORROW

modernize
PRODUCTION CONTROL *at low cost...*



Standard Instrument production controls provide immediate benefits to manufacturers and users of packaging—from production of package to filling lines.

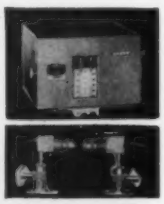
TALLY COUNT—count and batch high speed production electronically, actuate mechanisms at any pre-set count.

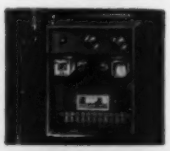


TIME RECORDER-TOTALIZER—record on tape the on-off pattern of any machine, and total its actual productive time.

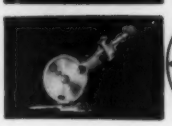
TALLY-PRINT — print-out production totals on time-indexed tape, at predetermined intervals.

ROBOT-EYE PHOTO-ELECTRIC CONTROL—count, inspect, sort, start and stop machinery photo-electrically.





For complete information on the above and other production controls, write for Brochure YP-5.



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INSTRUMENT CORP.
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CIRCLE 282 ON READER SERVICE CARD

New adjustable differential pressure switches

ACTUATION RANGE:
0.25" of water column to 200 psi differential.
WORKING PRESSURE: to 5000 psi.

DELTADYNE®

Accurate • small • lightweight • leak-proof
vibration-resistant • performance-proved

WRITE FOR LITERATURE

0.25" to 16" of water column, 250 psi working pressure — BULLETIN E7
0.125 to 16 psid actuation, 250 psi working pressure — BULLETIN E8
15 to 200 psid actuation, 5000 psi working pressure — BULLETIN E9

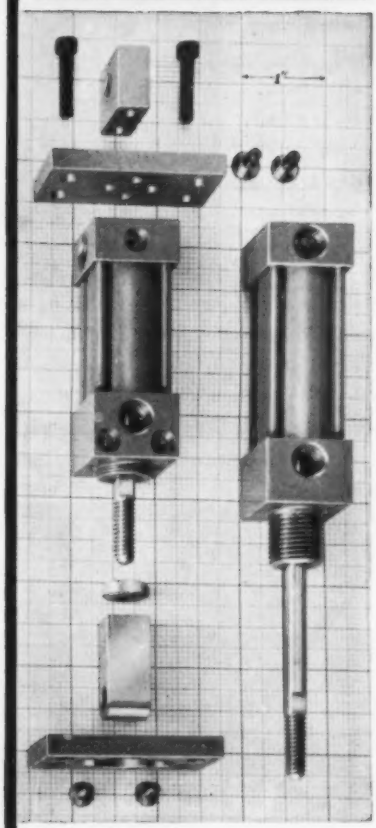
PALL

PALL CORPORATION • GLEN COVE, N. Y.

CIRCLE 230 ON READER SERVICE CARD

CIRCLE 283 ON READER SERVICE CARD

HOW SMALL
do you want 'em?



Hannifin offers new "Midget-Air" 200 psi cylinders in ¾", 1" and 1⅛" bores, double-acting or spring-return. Two basic models, "universal" and "nose-mounting." Universal models come drilled and tapped for mounting, or for use with any combination of the mounting attachments pictured. Delivery is off-shelf in standard strokes, shipment in ten days to specified stroke lengths. Want dimensions and prices? Write:

PARKER HANNIFIN CORPORATION
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS
2299-PHa
HANNIFIN COMPANY
A DIVISION
525 South Wolf Road • Des Plaines, Illinois
EUROPEAN DIVISION • PARKER-HANNIFIN N.V.
SCHIPHOL • THE NETHERLANDS

CIRCLE 284 ON READER SERVICE CARD

reservoir walls. O-rings seal mounting bolts, in both heavy cast aluminum frame and between gage and reservoir wall to completely seal entire unit when bolted into place. **Federal Brass Mfg. Co, Elmira, NY.**

Circle 436 on Reader Service Card

Breadboarding system . . .

uses helical spring connectors and standard, solid hookup wire in place of solder connections. Suitable for transistors, diodes and other subminiature components easily damaged by soldering. Connectors accommodate foil-type leads, as well as leads with diameters up to 0.050 in. System, packaged in a carrying case, comprises connectors, tube and transistor socket adaptors, potentiometer and switch adaptors and hardware supply. Priced at $34.50; delivery in 2 wk. **Electronic Training Aids, PO Box 53, Cambridge 41, Mass.**

Circle 437 on Reader Service Card

Pressure gage . . .

has integrally cast solid wall separating bourdon-tube assembly from ring, glass and dial. This is said to protect viewer from explosions resulting from accidental overpressuring of the bourdon tube. Entire back of case is covered by a spring-mounted pressure-releasing plate, held in place by a knurled knob. Less than ½ psi pressure forces plate open, discharging pressure medium out of back of case, away from operating personnel. Available in two case styles—a back-flange model with three integrally cast lugs on back face of flange and a flush mounted model. Sizes are 4½, 6 and 8½ in. **J E Longergan Co, 211 Race St. Philadelphia 6.**

Circle 438 on Reader Service Card

Nitriding process . . .

not only increases surface hardness but is said to improve wear resistance and toughness of ferrous metals. The West German-developed process is a chemical method of impregnating plain or alloy steels or cast iron with a controlled concentration of nitrogen in a low-temperature (1050 F) molten-salt bath, as opposed to conventional nitriding. Time at temperature is considerably less, minimizing possibility of distortion, and although not used primarily to form a "case", depth of nitrogen penetration is said to be considerably greater. Can be applied to any ferrous metal and reportedly increases corrosion resistance (except

continued on page 233

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ALUMINUM
Phoenixspun®
FROM
2" THICK
PLATE

and
CONTOUR
MACHINED
TO SPACE
AGE TOLERANCES

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Thicknesses up to 2" and diameters up to 170" are readily PHOENIXSPUN from high strength aluminum alloys, titanium, and exotic metals. Tolerances of plus or minus .005" are accurately maintained with this radically new and exclusive, heavy duty, powerspinning equipment. A wide range of conventional spinning requirements can also be produced economically by the various PHOENIX Metal Processing methods. If your metal forming project involves outer space, electronic, nuclear or general industrial products contact us at once.

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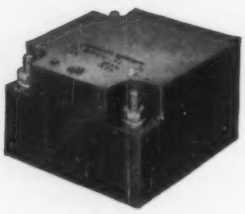

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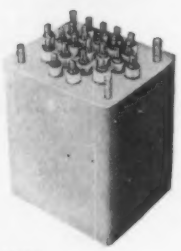

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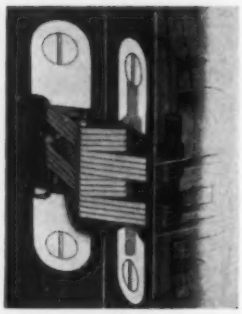

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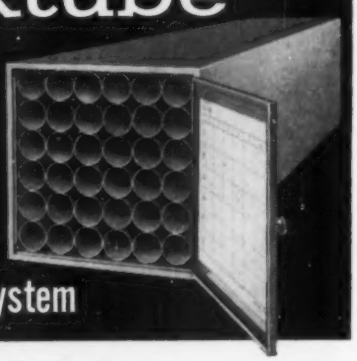

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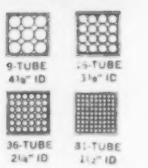

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for stainless steels), raises resistance to galling, provides better wear properties, increases fatigue strength, reduces cracking, and raises rolling fatigue limits. Has been used experimentally and in production on such parts as crank and cam shafts, gears, rocker arms, dies, cylinder liners, engine heads, etc. **Kolene Corp, 12890 Westwood, Detroit.**

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Brake caster . . . is assembled with a stem that includes a brass ring, providing friction inside socket to hold caster in place. The heavy-duty, top-bearing unit is available in bright steel or zinc-plated finish with 1¾ or 2-in. wheel in black phenolic, polystyrene or rubber. **National Lock Co, Rockford, Ill.**

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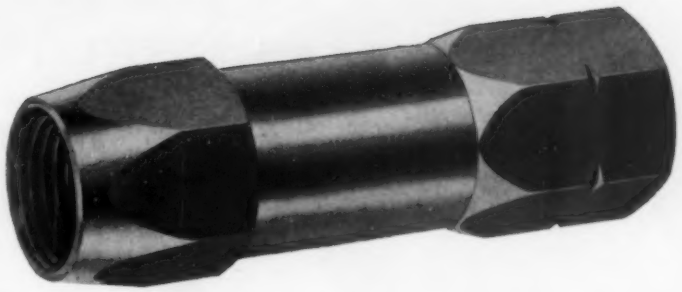

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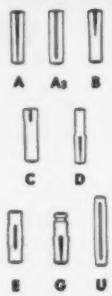

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DESIGN LITERATURE

Modern Materials: Advances in Development and Applications. Vol II

Edited by HENRY H HAUSNER, Consulting Engineer, NYC. Academic Press Inc, 111 Fifth Avenue, New York 3. 6¼ x 9¼, 413 pp. $12.50

It is difficult to cover widely divergent subjects in a single volume because there is no continuity from one subject to the next. But advancements are seldom made along a broad front. Instead, they usually show up as developments in specific areas.

This book, second volume of a series, covers these materials and their related fabrication processes: polymer-modified papers, sprayed ceramic coatings, boride ceramics, titanium and materials for welding and soldering.

A detailed treatment of scattered subjects, this book is useful only if you need information on the specific materials covered. –HLK

Theory of Elastic Stability (2nd Edition)

STEPHEN P TIMOSHENKO AND JAMES M GERE, Stanford University. McGraw-Hill Book Co Inc, 330 West 42nd St, New York 36. 6¼ x 9¼, 541 pp. $15.

An extensively rewritten version of the established text and reference work, first published in 1936, this book presents the fundamental theory of buckling of bars, plates and shells. The new second edition brings the subject matter up-to-date. Some of the significant changes in the second edition are in the treatment of torsional buckling of columns and lateral buckling of beams. But the emphasis, as in the first edition, is on fundamental theory.

This book begins with the analysis of beam columns, then proceeds to elastic buckling of bars, Chap. 2. This chapter has been enlarged to include buckling under the action of nonconservative forces, periodically varying forces, and impact. Chap. 3 covers inelastic buckling of bars; Chap. 4 describes experiments on buckling of bars.

A new chapter on torsional buckling, Chap. 5, has been added, and Chap. 6 on lateral buckling of beams has been extensively revised. Chap. 7 deals with the buckling of rings, curved bars, and arches. Chap. 8 and 10 are on bending of plates and shells, and Chap. 9 and 11 on buckling of plates and shells.

Analog Computer Components

R M HOWE. D Van Nostrand Co Inc, Princeton, NJ. 6 x 9, 261 pp. $7.50.

The mathematician may be satisfied with a theoretical approach to analog computation, but the man who actually manipulates the hardware needs to know more than that. He needs to know how to get the most out of his machine, how it works, where errors may occur and how they may affect the solution, what peripheral equipment is available and what it will do. This book offers an answer to those questions. In separate chapters, the author analyzes and describes amplifiers, multipliers, function generators, recorders, and miscellaneous equipment. The remaining two chapters are devoted to system considerations and errors. The components described are actual commercial items; when discussing servo-multipliers, for example, the author gives specifications and characteristics of those manufactured by Electronic Associates, Berkeley, Reeves, and Goodyear Aircraft. The appendix includes 42 photographs of typical equipment: complete computers, patchboards, amplifiers, multipliers, function generators, recorders and plotters.

Science in Writing

J R HENN. The Macmillan Co, 60 5th Ave, New York 11. 8 x 5½, 248 pp. $4.75.

Looking for examples of good science writing? Coming out of his ivory tower at Cambridge, this British lecturer in poetry and drama goes into science literature and brings out 31 samples—from Pliny through Francis Bacon to C. G. Jung and the moderns. The anthology idea is a good one: enjoy the good writing of others while you let its methods soak into you. The author then gives a 21-page run-through of pointers about writing. Most samples in the anthology portion are of the essay type and only one, Sir Harry Ricardo's superbly

continued on page 237

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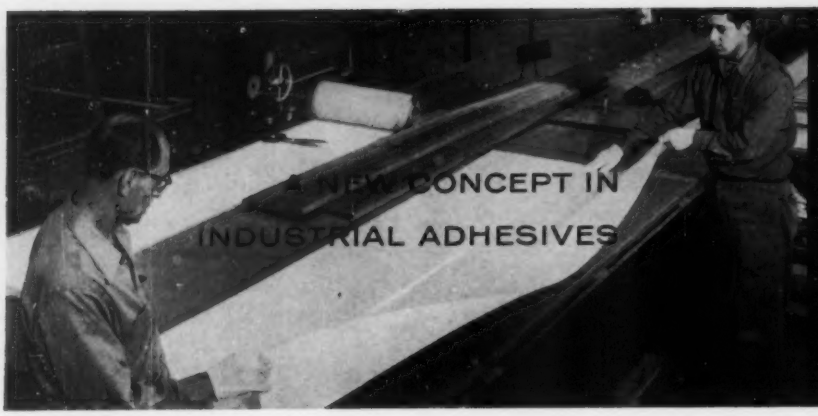

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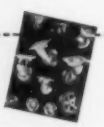

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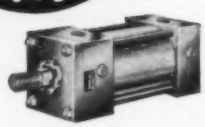

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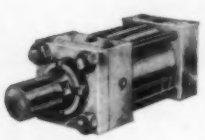

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written "The Design of Bearings and Crankshafts," is of direct interest to PRODUCT ENGINEERING readers. But is there any harm in browsing through the fields of science?—good writing is good writing wherever you find it. —WG

Essentials of Dielectromagnetic Engineering

H M SCHLICKE, Manager High Frequency Labs, Allen Bradley Co. John Wiley & Son Inc, 440 Park Avenue South, New York 16, 6 x 9¼, 242 pp. $9.50.

Essentially a nomograph on dielectrics such as barium titanium and soft ferrites, the book covers that field thoroughly. Requires a thorough background in electronics and magnetics, and gives both theory and design of devices and circuits.

Microelectronics

Report of Office of Naval Research Study Group, Office of Technical Services, PB 161890, US Department of Commerce, Washington 25, DC. 8 x 10, 15 p. 50¢.

Primarily a review (Final Report of Office of Naval Research Study Group on Microelectronics) of research contracts, completed and in progress, this booklet will be of interest mainly to those who want to know "what has gone before."—ARG

High-temperature Insulation for Wire

J N HARRIS, J D WALTON JR. Office of Technical Services, PB 161788, US Department of Commerce, Washington 25, DC. 8 x 10½. 33 pps. $1.

The latest in a growing series of reports on insulation for conductors that must operate in the 1000-F range, this one deals with copper wire, aluminum-clad, anodized, and enameled.

Other Books of Interest

Semiconductors

SB-435. Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8 x 10¼, 20 pp. 10¢.

Bibliography of reports listed in Office of Technical Services monthly abstract journals for the period April 1950 to Oct 1960.

Thermoelectricity

SB-432. Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8 x 10¼, 10 pp. 10¢.

A bibliography of reports listed in Office of Technical Services abstract journals during the period 1945 to 1960.

Powder Metallurgy

SB-423. Office of Technical Services, US Dept

continued on page 239

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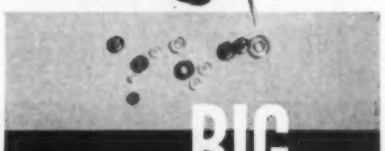

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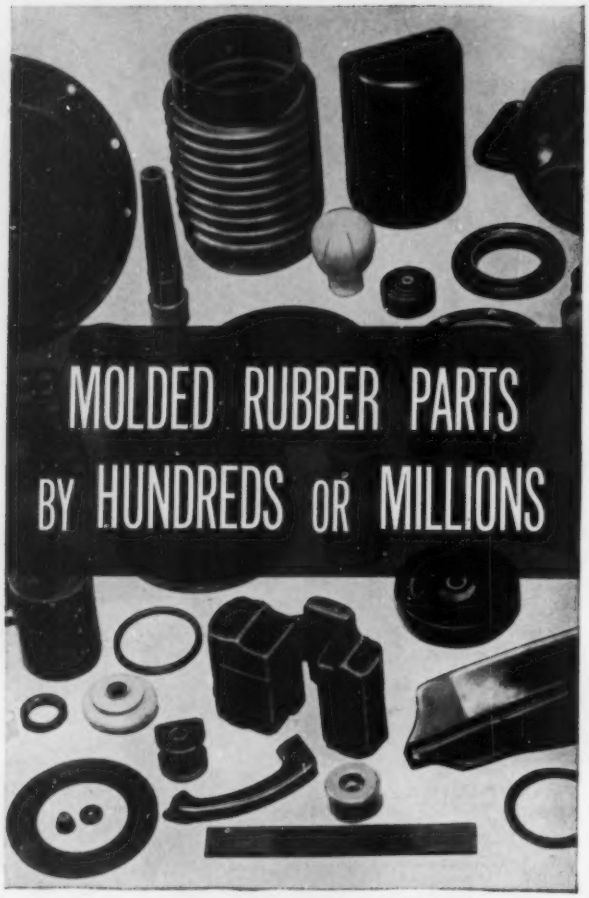

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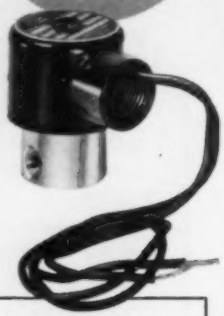
MARSH *Master-mite* SOLENOID VALVES



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of Commerce, Washington 25, DC. 8 x 10¼, 10 pp. 10¢.

A bibliography of reports listed in Office of Technical Services abstract journals during period May 1958 through Sept 1960.

Magnetostriction

SB-427. Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8 x 10¼, 6 pp. 10¢.

A bibliography of reports listed in Office of Technical Services abstract journals for the period 1946 to Sept 1960.

Engineering and Technical Conventions—1961

Deutsch & Shea Inc. Industrial Relations News, 230 W 41st St, NY 35. 8½ x 11, 41 pp. $4.

The meetings planned by more than 100 societies and other organizations for 1961 are listed—and where data was available, meetings are also listed for up to five years ahead.

A Compendium of the Properties of Materials at Low Temperature (3 parts)

Part I—Properties of Fluids, 489 pp.
Part II—Properties of Solids, 333 pp.
Part III—Bibliography of References (Cross-indexed), 161 pp.
V J Johnson, General Editor. Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8 x 11.

An Introduction to Transition-metal Chemistry

L E Orgel. John Wiley & Sons Inc, 440 Park Ave South, NY 16. 5½ x 8¾, 180 pp. $4.50.

Discusses the elementary theory of the chemistry of the elements from titanium to zinc. Gives non-mathematical treatment of ligand-field theory.

On the Viscosity of Liquid Metals

AEO-tr-4202. A. M. Korol'kov. Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8 x 10¼, 5 pp. 50¢.

Application Guide: Silicon Power Transistors

Semiconductor and Materials Div, Radio Corp of America, Somerville, NJ. 8½ x 11, 28 pp. 50¢.

ABSTRACTS FROM THE LITERATURE

German-English Kinematics Glossary

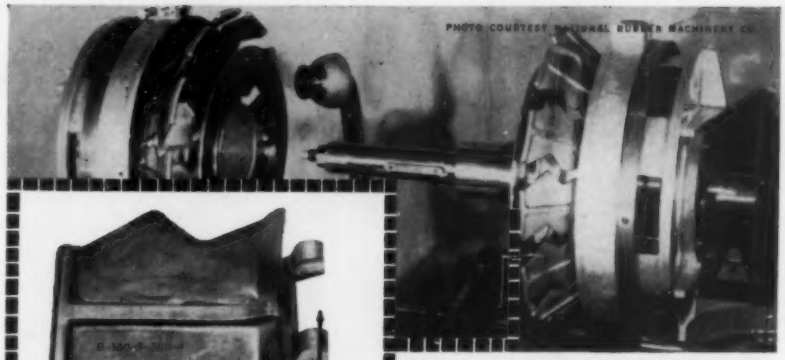
This glossary was developed because a substantial part of the ever-growing literature on kinematics is of German origin. Designed to be used in conjunction with one or more of the standard German-English general dictionaries.

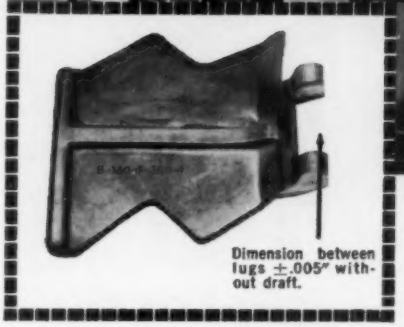
"Kinematics—A German-English Glossary," Hartenberg (Northwestern University) and Goodman (General Electric). Mechanical Engineering, Dec '60. ASME, 29 W 39th St, New York 18.

Metering Pumps

Author derives a figure of merit for metering pumps and shows how it can

continued on page 241





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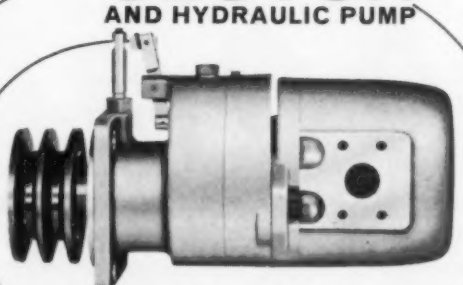

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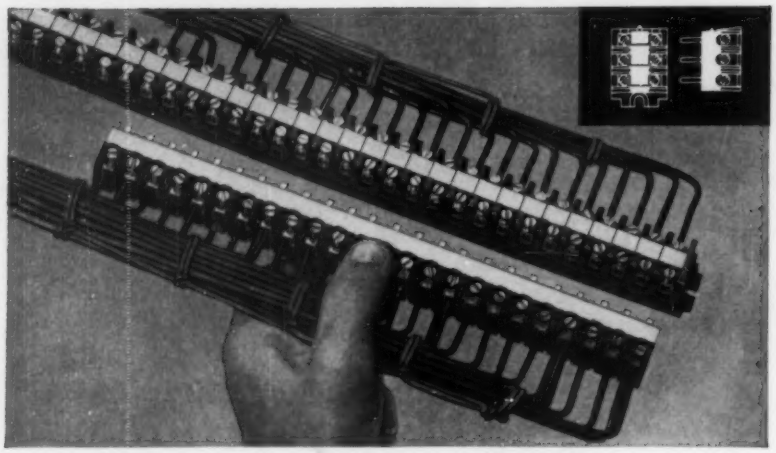

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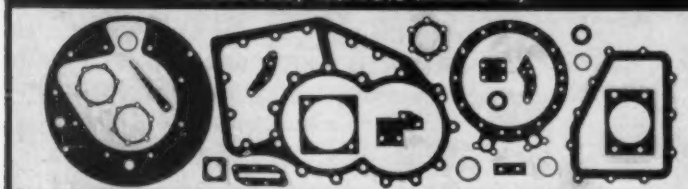

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be used to predict performance when going from pilot plant to full-scale operation.

"Predicting Performance of Metering Pumps," A. Beerbower, Esso Research & Engineering Co. Control Engineering, Jan '61, 330 W 42nd St, New York 36.

Merit-rating Engineers

Describes system of rating engineering personnel based on a combination of assigned level of responsibility and a method of evaluating individuals' quality of application to their responsibilities.

"New System of Merit Ratings," K. D. Holland. Mechanical Engineering, Dec '60. ASME, 29 W 39th St, New York 18.

Mechanical Feedback for Electrohydraulics

Describes system originally developed for aircraft control based on mechanical position feedback, used to eliminate electrical position transducers and associated circuitry.

"Using Mechanical Feedback in Electrohydraulic Systems," Garnhost and Kolm, Moog Servocontrols Inc. Automatic Control, Dec '60, 430 Park Ave, New York 22.

Effects of Contamination on Relays

An investigation answers the three questions: What is the most likely source of the trouble? Can the source of trouble be eliminated or minimized? Will doing so give the desired quality improvement?

"The Effects of Contamination on Relay Performance," by Paul Mahler, Picatinny Arsenal, Dover, N.J. Published in the NARM Relay Symposium Papers at the 8th Annual Relay Symposium at Stillwater, Okla.

Theory of Fluid Sealing

Factors affecting performance of contact seals are mainly leakage, wear and power consumption. From the general equations for fluid motion, basic laws for leakage, wear and power requirements are deduced. Since contact seals are either radially or axially acting, equations are included for both types. Pressure forces and their influence on wear and leakage are discussed as well as improvement to be gained by hydraulic balance. Equations deduced consider flow in the critical seal parts to be incompressible, steady, isothermal, laminar, two-dimensional and single-phase. No

consideration has been taken of the influence of shaft eccentricity, vibrations and surface conditions or to power consumption and heat development by rotating seal parts.

"Theory of Fluid Sealing," D. Huhn, Gustav Huhn, Stockholm, Sweden. British Hydromechanics Research Association, Harlow, Essex, Eng.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 246.

SPRINGS—Manual, 16 pp. Explores basic data on helical and flat springs, wire forms, special fasteners, precision metal stampings and assembled spring-like devices. Spring sizes, mechanical properties and recommended uses of commonly-used spring materials and cold-rolled spring steels are tabulated. Includes design briefs and case histories. Associated Spring Corp, Bristol, Conn.

Circle 443 on Reader Service Card

MOTOR COUPLINGS—Folder 2975, 6 pp. Tabulates stock bore sizes, specifications and dimensions of geared couplings for shafts up to $2\frac{3}{8}$ in. Design features are discussed and illustrated. Link Belt Co, Dept PR, Prudential Plaza, Chicago 1.

Circle 444 on Reader Service Card

CERAMICS—Chart 611. Traces mechanical and electrical properties of most frequently used compositions. Includes thermal expansion, dielectric strength and volume resistivity curves. American Lava Corp, Manufacturers Rd, Chattanooga 5, Tenn.

Circle 445 on Reader Service Card

VARIABLE POTENTIOMETER—Catalog, 4 pp. Contains electrical, mechanical and performance specifications of 3-w unit, as well as graphs of available tapers, derating curve and outline drawings. Reon Resistor Corp, 155 Saw Mill River Rd, Yonkers, NY.

Circle 446 on Reader Service Card

CYLINDER BOOSTERS—Bulletin B-100, 4 pp. Outlines factors for determining booster sizes. Tables cover booster ratios and volume output; dimensions; and cylinder and tank selections. Includes outline drawings of 10 models. Milwaukee Cylinder Co, 5757 S Pennsylvania Ave, Cudahy, Wis.

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continued on page 243

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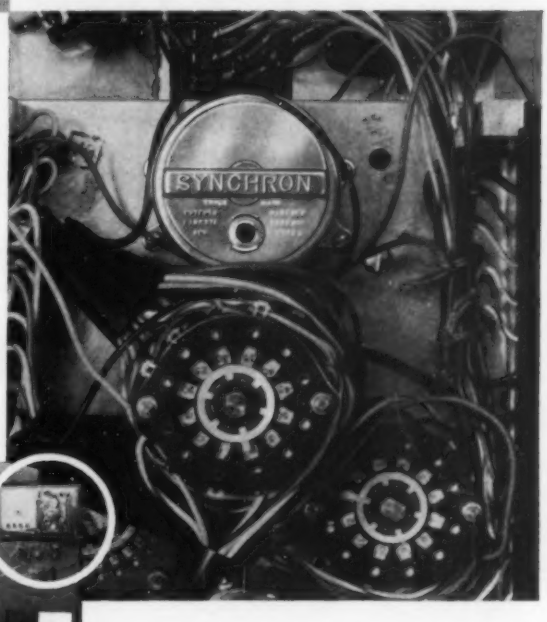

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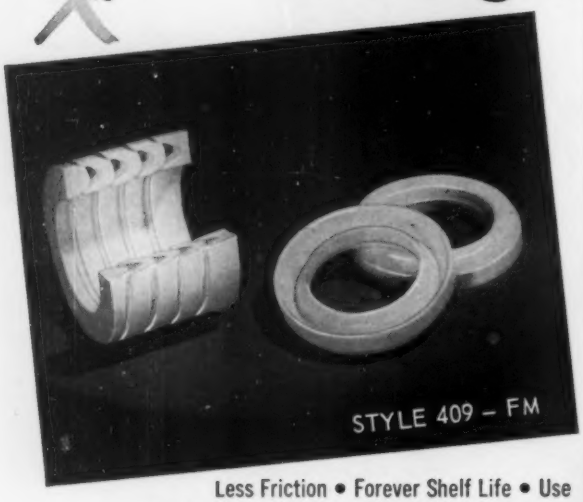

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NICKEL ALLOYS—Data sheet T-1. Lists corrosive media in which nickel alloys are generally resistant and plots corrosion resistance of one composition vs 18-8 stainless steel in sodium hydroxide, and sulfuric, nitric and acetic acid. Wall Colmonoy Corp, 19345 John R St, Detroit 3.

Circle 448 on Reader Service Card

PRESSURE TRANSDUCER—Bulletin 4329, 2 pp. Covers input, output, environmental and physical specifications of medium-to-high range unit measuring pressures from 0-100 psi to 0-5000 psi absolute. Design features are described. Consolidated Electrodynamics Corp, 360 Sierra Madre Villa, Pasadena, Calif.

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RECOVERING WASTE ENGINE HEAT—Booklet, 24 pp. Deals with recovery of wasted heat from internal-combustion engines as a fuel-cost savings. Schematic layouts illustrate applications, including utility plant, marine vessels, etc. Specifications are outlined for recovery silencers. J B Beaird Co Inc, 6200 St Vincent Ave, Shreveport, La.

Circle 450 on Reader Service Card

MAGNETIC DRUMS AND HEADS—Brochure, 28 pp. Contains specifications and outline drawings of magnetic memory drums and drum and tape heads. Photographs trace quality-control and production techniques. Magne-Head Div, General Instruments Corp, 3216 W El Segundo Blvd, Hawthorne, Calif.

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POLYETHYLENE GLYCOLS—Booklet F-4772E, 65 pp. Charts physical properties and outlines solubilities, specification limits, test methods, toxicological properties, etc. Discusses material's use in adhesives, wood, paper and cellulose products, resins, agricultural products, ceramics, lubricants, electronics, etc. Union Carbide Chemicals Co, Div of Union Carbide Corp, 270 Park Ave, New York 17.

Circle 452 on Reader Service Card

FRACTIONAL-HP MOTORS—First issue, external publication, 4 pp. Quarterly series on performance, selection, application and maintenance of fractional and subfractional-hp motors debuts with article on lubricating instrument motors. Holtzer-Cabot Motor Div, 125 Armory St, Boston 19.

Circle 453 on Reader Service Card

INFORMATION STORAGE AND RETRIEVAL—Folder, 10 pp. Explains automated system, composed of recording camera and search and retrieval unit, and traces entire process from analyzing and indexing initial documents to printing hard

continued on page 245

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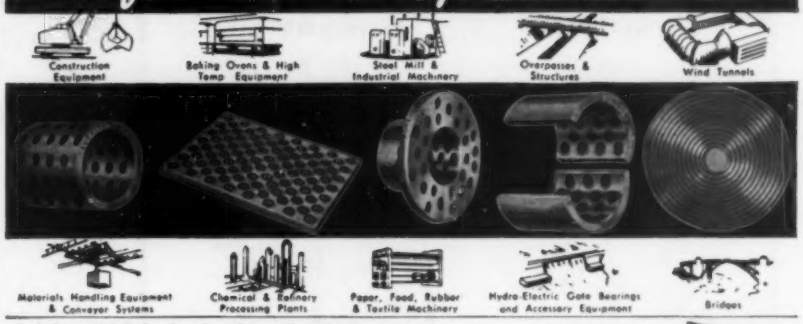
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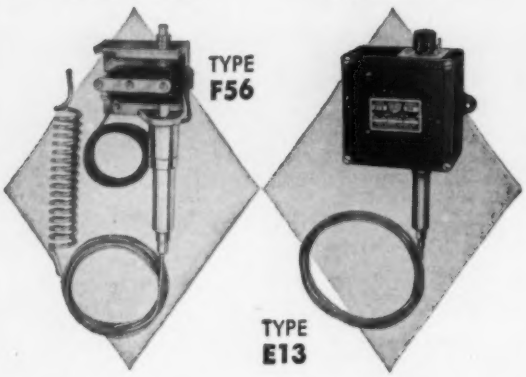

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Switch Types	N.O., N.C., or Double Throw, no neutral position.
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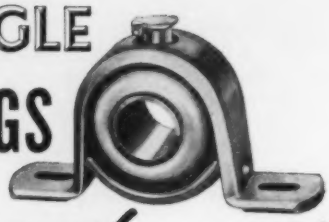

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DESIGN LITERATURE.....continued

copies of requested information. FMA Inc, 142 Nevada St, El Segundo, Calif.

Circle 454 on Reader Service Card

TRANSFORMERS—Bulletin CVS-3631, 4 pp. Tabulates electrical and mechanical specifications of standard sinusoidal constant-voltage types with output ratings of from 60 to 7500 v-amp. Illustrations include dimensional drawings and oscillograms showing typical output voltage wave shapes under varying load conditions. Sola Electric Co, Busse Rd at Lunt, Elk Grove Village, Ill.

Circle 455 on Reader Service Card

TAPE AND FILM DRIVE SPROCKETS—Brochure SP-52, 8 pp. Supplies dimensions, number of teeth and other data on stock types and sizes for 16, 35 and 70mm film. Outline drawings are included. LaVezzi Machine Works, 4635 W Lake St, Chicago 44.

Circle 456 on Reader Service Card

DIGITAL STRAIN INDICATOR—Bulletin 330, 2 pp. Details design features and electrical specifications of a calibration instrument for strain-gage bridges with resistance arms from 60 to 1000 ohms. Dynametrics Corp, Northwest Industrial Park, Burlington, Mass.

Circle 457 on Reader Service Card

LETTERHEAD REQUESTS ONLY

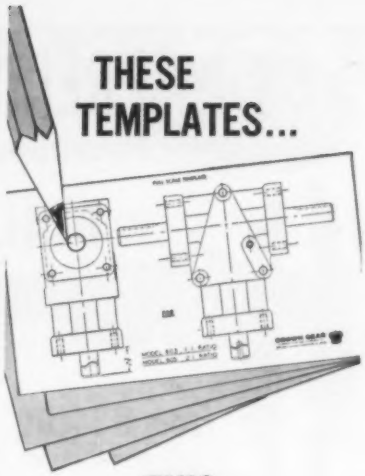
Manufacturers who published following literature asked that requests for copies be made on company letterheads.

LAMINATED PLASTICS—Catalog D-61, 20 pp. Covers grade selection, range of sizes, and typical property values of industrial laminated plastics in sheet, rod and tube form. Metal-clad grades are treated. Continental-Diamond Fibre Corp, Newark, Del.

INSTRUMENT MOTORS—Bulletin IM-1, 28 pp. Contains dimensional drawings, rating charts, wiring diagrams, listings and photographs. Discusses availability of engineering service, development and testing procedures and typical applications. Bodine Electric Co, 2500 W Bradley Pl, Chicago 18.

FOR MORE CATALOGS AND BULLETINS

. . . 1600 of 'em—see your copy of Product Engineering's Mid-Sep 1960 Design Digest. There you will find helpful design literature, classified under 10 different headings, from important manufacturers and suppliers of components, materials, power and control systems, manufacturing processes.



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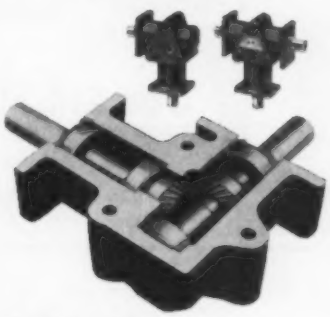

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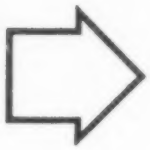

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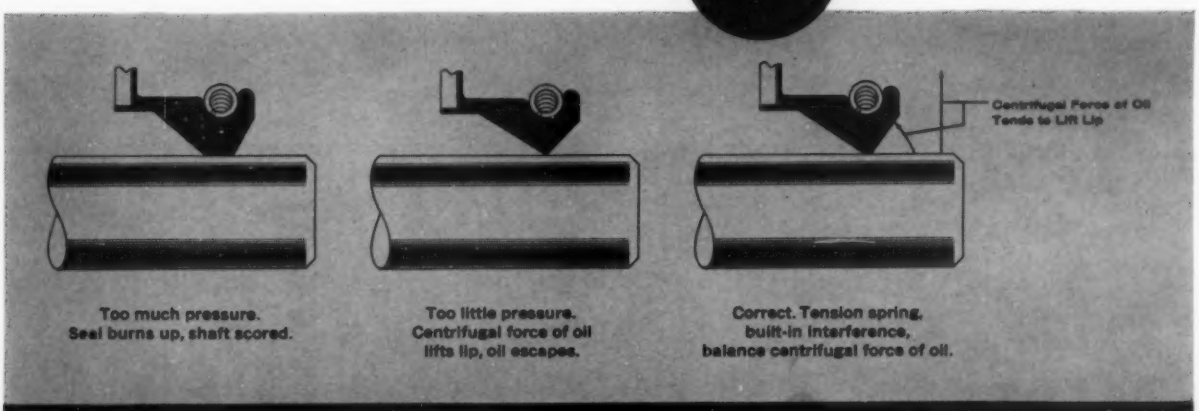

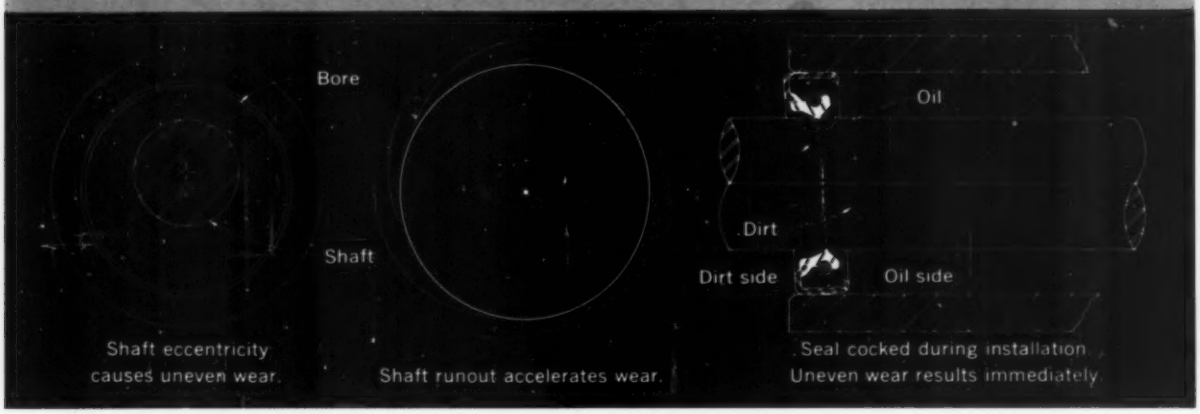

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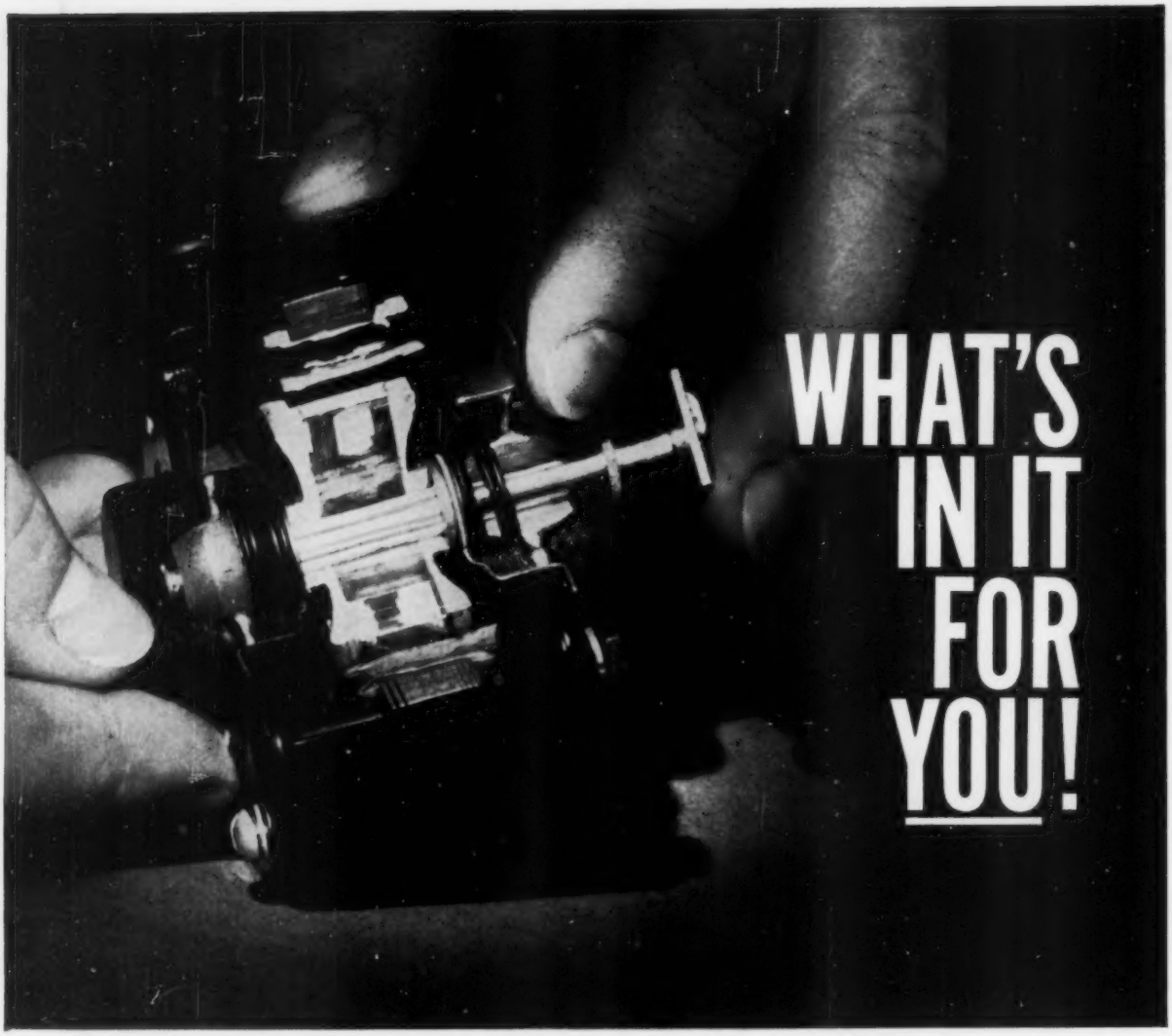

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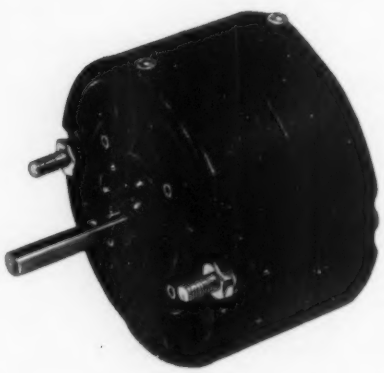

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